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# CHARLES JUDSON HERRICK: IN MEMORIAM

W. ALFRED EVERHART[1]

On January 29, 1960, Dr. Charles Judson Herrick, one time student and former professor at Denison University, died at his home in Grand Rapids, Michigan. He was 91 years of age.

Newspaper accounts[2] next day listed, among others, the following biographical facts.

He was born in Minneapolis, Minnesota, on October 6, 1868, a son of Henry Nathan and Anna (Strickler) Herrick. He was enrolled in Doane Academy at Granville (Ohio) in 1885 and remained at Denison University through his sophomore year. At that time his brother, Dr. Clarence Luther Herrick, was a very able and active professor (Geology and Natural Sciences) at Denison. When Professor Herrick joined the faculty of the University of Cincinnati in 1889 young C. J. Herrick transferred there, earning the Bachelor of Science degree in 1891.

During the following year he taught natural sciences in the Academy at Granville, then served for a year on the teaching staff at Ottawa University in Kansas. He returned again to Denison as a graduate student and Fellow in Biology, earning a degree of Master of Science in 1895. He remained as an instructor in biology, studied (on leave) at Columbia University for a year, became Professor of Zoology at Denison in 1897, and served ably in that capacity until 1907. He received his Ph.D. degree from Columbia in 1900.

Dr. Herrick then became Professor of Neurology at the University of Chicago, where he came to be recognized as a leader in his field of specialization—the study of the physiological processes of the brain. He was also an extensive writer and lecturer. Many of his words were addressed to the general public, to whom he expounded the idea that thought processes were bodily functions in the same way as are the movement of muscles or the circulation of blood.

During his active years at the University of Chicago he served also, in World War I, as an officer (Major) in the Sanitary Corps (and Medical Museum) of the United States Army. His term of service as Professor of Neurology was terminated in 1934. And after three additional years as a teacher of anatomy he retired (1937), as Professor Emeritus. His later (and still active) years were spent in retirement in Grand Rapids.

For over fifty years, beginning in 1894, Dr. Herrick served as editor or board chairman of the *Journal of Comparative Neurology*. He was also a supporter of, and a contributor to, the *Journal of the Scientific Laboratories* (Denison Univer-

[1] Editor, Journal of the Scientific Laboratories, Denison University.

[2] Notably in the New York Times and in the Newark (Ohio) Advocate.

sity). Both of these journals had been founded by Dr. Clarence Luther Herrick some years prior to his death in 1904.

In addition to his work as an editor Dr. C. J. Herrick was also an author of text books in neurology and of more than 150 scientific articles. He was the recipient of honorary degrees (Doctor of Science) from the University of Cincinnati (1926), Denison University (1930), and Columbia University (1931). He served as a trustee of the Denison University Research Foundation, 1943–1959.

In the afternoon of Tuesday, February second, a brief memorial service honoring the life and work of Dr. Herrick was held in the Rhoades Chapel of the First Baptist Church in Granville, Ohio, the Reverend James B. Ashbrook officiating. Burial followed in the College Cemetary on the Denison campus, with representatives of the University administrators and faculty, the Denison Scientific Association and friends in attendance.

Among the pertinent statements by the Reverend Mr. Ashbrook in the memorial service for Dr. Herrick were these.

"The psalmist speaks of the goodness of our world and of our place and responsibility in that world.

> The earth is the Lord's, and the fulness thereof; the world and they that dwell therein.
>
> For He hath founded it upon the seas, and established it upon the floods.
>
> Who shall ascend into the hill of the Lord? Or who shall stand in His holy place of living truth?

It is in the light of living truth being present in all levels of creation, and of man's search for and response to truth, that the writer of *Job* can say:

> Ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee.
>
> Or speak to the earth, and it shall teach thee; and the fishes of the sea shall declare unto thee.
>
> Who knoweth not in all these that the hand of the Lord hath wrought this?

Dr. Herrick's scholarly knowledge was not that of the narrow-minded specialist, but that of the pioneering man. All reality possesses a profound simplicity under the surface complexity. He sensed that deep underlying unity of reality, and so could never be content with preliminary conclusions and premature syntheses. In him we find a profound respect for fact, a humility toward experience, and a sense of responsibility in judgment.

Because of the increase in scientific knowledge in the past generation it is no longer possible for one man to be at the center of a discipline. Yet in Dr. C. Judson Herrick we find one who not only has been at the center but also at the source of a discipline as well. In many ways his death marks the end of an age—an age in which one man can be in the pivotal position. This attests both to his greatness as a scientist and to the ripeness of the time in which he appeared on the stage of history."

# A STUDY OF THE EFFECTS OF FERTILIZERS ON VEGETATION GROWTH, PLANKTON POPULATION AND NUMBERS, AND POUNDS OF BASS HARVESTED—IN EIGHT ONE ACRE PONDS

GEORGE D. MORGAN[1]

One of the problems in our fish hatcheries is the control of submersed aquatic vegetation. This is especially true of shallow ponds and shallow lakes. This growth sometimes becomes so abundant that it interferes with the harvesting of the young bass. Many become entangled in the vegetation and fail to reach the kettle during pond drainage. To control this vegetation sodium arsenite has been used extensively. This chemical, used in excessive concentrations, can be harmful to the plankton life upon which the young fish depend for most of their food. Also, the decomposition of plant life caused by this chemical may result in a depletion of the dissolved oxygen, which in turn may cause a fish kill.

Another method of control of submersed vegetation is by the use of fertilizers. Usually, fertilizer is used to increase the production of plankton and hence an increase in fish productivity. It has also been shown that submersed plant growth may be controlled by the use of fertilizers. However, when used for this purpose the chemical composition of the water, the time of application and the kind and the amount of fertilizer used are important factors to be considered. It has been shown that if fertilizer is applied in early spring the water will become so colored that little or no sunlight will be available for plant growth.

In order to determine the fertilizer which would control the growth of submersed vegetation and at the same time would not interfere with the food supply of the small fish, an experiment was proposed by Mr. Ancil D. Holloway, Regional Supervisor, Branch of Fish Hatcheries, U.S. Fish and Wildlife Service, Minneapolis, Minnesota. The experiment was carried out by the author and by the personnel at the Federal Fish Hatchery, Hebron, Ohio. The author was responsible for all plankton studies, the collection of data on vegetation growth, depth of ponds, pH, temperature, turbidity, fertilizer used, fish stocking and fish harvesting. The stocking, harvesting and the application of the fertilizer were done by the personnel at the hatchery.

## PROCEDURE

Nine one acre ponds were used in the study. The water supply was from the canal which is fed from Buckeye Lake. The filling of the ponds was begun on April 24, 1959.

[1] Professor of Biology at Denison University and Fishery Research Biologist, U. S. Fish and Wildlife Service.

*Stocking of the Ponds*

All ponds with the exception of Pond $D_1$ were stocked as uniformly as possible with advanced large mouth bass fry, ½ to ¾ inch in length. The number, pounds, number per pound, and the stocking dates were as follows:

On May 22. Ponds $C_3$, $D_3$ and $E_3$ were stocked with 15 pounds at 3,350 per pound, a total of 50,250.

On May 23. Ponds $C_2$, $D_2$ and $E_2$ were stocked with the same number of bass and the same number of pounds as the above ponds.

On May 25. Pond $C_1$ was stocked with the same number and the same number of pounds as the above ponds. Pond $D_1$ was not stocked with bass because of a lack of fish. Pond $E_1$ was stocked with 20 pounds of bass at the rate of 2,000 per pound, a total of 40,000.

*Fertilizing Procedure*

The nine ponds were arranged in groups of three. Each group was fertilized with a different formula, which was as follows:

Series 1. Ponds $C_1$, $D_1$ and $E_1$ with 10-0-0

Series 2. Ponds $C_2$, $D_2$ and $E_2$ with 10-10-0

Series 3. Ponds $C_3$, $D_3$ and $E_3$ with 10-20-0

The fertilizer used was Davco, granulated, 20% ammonium sulphate and 20% super phosphate. These were in separate bags and were mixed to give three different proportions or formulae, 10-20-0, 10-10-0 and 10-0-0. These numbers express the nitrogen content, phosphoric acid content and the potash content respectively. To obtain a 10-20-0 content, or the equivalent of 100 pounds of 10% nitrogen and 100 pounds of 20% phosphoric acid, 50 pounds of 20% ammonium sulphate and 100 pounds of 20% super phosphate were mixed together. For 50 pounds one-half of the number of pounds given above of ammonium sulphate and super phosphate were used. To obtain a 10-10-0 formula, or the equivalent of 100 pounds of 10% nitrogen and 100 pounds of 10% phosphoric acid, 50 pounds each of 20% ammonium sulphate and 20% super phosphate were mixed together. For 50 pounds of 10-10-0 one-half of this proportion of each of the above compounds were used. To obtain a 10-0-0 formula, or the equivalent of 100 pounds of 10% nitrogen and no phosphoric acid nor any potash, 50 pounds of 20% ammonium sulphate only was used. For 50 pounds of 10-0-0 twenty-five pounds of 20% ammonium sulphate was used.

The first application of fertilizer was at the rate of 100 pounds per acre pond. It was placed in the kettle at the inlet when the water was turned on April 24. After the first application all ponds were fertilized at the rate of 50 pounds per acre pond every seven days for a period of eight weeks (nine weeks including the first application of 100 pounds on April 24). After the first application the fertilizer was distributed from the sides of the ponds. The last application was on June 19, five days before the first pond was drained for the harvesting of bass.

*Harvesting*

The harvesting of bass was begun on June 24, 1959, and was continued through August 27 when the last pond was drained. The harvesting data included numbers, pounds, number of fish per pound, and the length range.

*Plankton Collections*

The collecting of plankton samples was begun on April 30 and was continued weekly through July 9 with the exception of Pond $C_3$. This pond was drained on June 24 and on June 30. All plankton samples were taken with a standard plankton towing net, No. 12 mesh, and 125 meshes to the inch. The net was towed behind a boat at about the same speed for the length of the pond.

At first the plankton organisms were killed with chloroform. This procedure was not feasible in this area since the plankton did not settle to the bottom of the sample flask and the zooplankton and phytoplankton did not separate very well. Hence the observation of the volume of each kind was unreliable. Therefore, the organisms were killed with a plankton preservative made up of 6 parts of distilled water, 3 parts of ethyl alcohol and 1 part of formalin. The organisms settled to the bottom of the sample flask, and the total volume of plankton and debris was determined. The separation of zooplankton and phytoplankton was not possible by this method. Therefore the author reverted to microscopic analysis to determine the numbers of zooplankton and phytoplankton. This was not possible when chloroform was used to kill the plankton since chloroform is not soluble in water and the sample would not mix in the counting chamber. A one cubic centimeter Sedgewick-Rafter counting chamber and a Whipple ocular micrometer disc were used for counting the organisms. The average of two counts was taken for each sample. The zooplankton were separated into numbers of Cladocera, Copepoda, Ostracoda and Rotifera.

The pH, turbidity and depth of each pond were taken weekly after a fish kill was observed.

*Vegetation Growth*

The growth of submersed and emergent vegetation, and filamentous algae, was observed weekly during the collecting period and compared with the growth at the time the ponds were drained.

## RESULTS

On June 16, in order to compare the growth of bass before the first pond was drained, a few bass were removed from each pond and measured, with the exception of Pond $D_1$. The growths at this time are given in Table 1. Also, included in this table are the growths at the time the fish were harvested.

TABLE 1

*Growth of Bass*

| Fertilizer Used | Pond | Length Range on June 16 (inches) | Draining Dates | Length Range When Harvested (inches) |
|---|---|---|---|---|
| 10-0-0 | $C_1$ | 1.4–1.8 | July 9 | 2.0–6.0 |
| 10-0-0 | $E_1$ | 1.2–1.4 | July 15–17 | 2.0–5.3 |
| 10-10-0 | $C_2$ | 1.4–1.8 | July 1, 7, 8, 9 | 2.2–6.0 |
| 10-10-0 | $D_2$ | 1.3–1.8 | July 17–Aug. 7 | 2.1–4.4 |
| 10-10-0 | $E_2$ | 1.3–1.6 | Aug. 21–27 | 2.0–5.3 |
| 10-20-0 | $C_3$ | 1.2–3.6 | June 24–30 | 1.2–3.6 |
| 10-20-0 | $D_3$ | 1.0–1.8 | Aug. 8–20 | 2.0–4.4 |
| 10-20-0 | $E_3$ | 1.0–1.5 | Aug. 28 | 2.0–5.3 |

HARVESTING DATA POND $C_3$

*Fish Production*

In order to compare weights, numbers and growth of bass one pond of each group was drained first. The first group drained included $C_3$, $C_2$, $C_1$, fertilized with 10-20-0, 10-10-0, and 10-0-0 respectively.

Pond $C_3$ was the first pond drained. Draining was begun on June 24 and completed on June 30. The total number of bass harvested was 42, 325. They weighed 52.6 pounds and averaged 812 per pound. The length ranged was 1.2 to 3.6 inches. Of the total number 475 were 3.6 inches in length and were probably cannibals.

Also 30,000 shad weighing 60 pounds and averaging 500 to a pound were removed from this pond. This made a total of 72,325 bass and shad and a total of 112.6 pounds of fish. Table 2.

*Vegetation Growth*

Vegetation was no problem in this pond, and required no cutting. The submersed vegetation consisted of only a few patches of Potamogeton in the shallow end. The emergent forms were also scarce and included a few cattails along the sides of the pond. There were no filamentous algae in this pond.

*Plankton Volume and Plankton Number*

This pond had the greatest volume and the greatest number of plankton of all of the ponds. The average volume and the average number were as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total number of Zooplankton | Total number of Phytoplankton |
|---|---|---|---|---|---|
| 11.9 | 108,571 | 955,000 | 440,000 | 1,319,500* | 2,310,000 |

* Note that the total number of zooplankton is greater than the sum of the different kinds of zooplankton. This is because of the addition of one sample which was not divided into the different kinds of zooplankton. The total number of zooplankton includes this sample. This applies to the total number of zooplankton in all ponds.

TABLE 2

*Fish production, pond depth and turbidity*

| | Ponds | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $C_3$ | $C_2$ | $C_1$ | $E_1$ | $D_2$ | $D_3$ | $E_2$ | $E_3$ |
| Fertilizer Used | 10-20-0 | 10-10-0 | 10-0-0 | 10-0-0 | 10-10-0 | 10-20-0 | 10-10-0 | 10-20-0 |
| Draining Dates | June 24, 30 | July 1, 7, 8 and 9 | July 9 | July 15, 16 and 17 | July 17, 22 and Aug. 7 | Aug. 8, 14 and 20 | Aug. 21, 27 | Aug. 28 |
| BASS | | | | | | | | |
| Number of pounds | 52.6 | 65.7 | 66.8 | 59.4 | 96.8 | 78 | 43.1 | 61.7 |
| Number | 43,325 | 22,705 | 13,195 | 10,514 | 22,010 | 19,000 | 5,788 | 6,738 |
| Length range (inches) | 1.2–3.6 | 1.8–3.9 | 2–6 | 2–5.3 | 2.1–4.4 | 2–2.4 | 2–5.3 | 2–5.3 |
| SHAD | | | | | | | | |
| Number of pounds | 60 | 45 | 25 | 220 | 85 | | 195 | 116 |
| Number | 30,000 | ? | 125 | ? | ? | ? | ? | ? |
| Length range (inches) | ? | 2.5–3 | 4–6 | 4–6 | 2–3 | ? | 3–5 | 4–6 |
| CARP | | | | | | | | |
| Number of pounds | | | | 2.5 | 123.7 | 280 | 216 | 202 |
| Number | | | | 18 | 165 | 2,000 | ? | ? |
| Length range (inches) | | | | 6 | 10–11 | 6 | 6–8 | 6–8 |
| Total pounds of fish | 112.6 | 110.7 | 91.8 | 281.9 | 305.5 | 358 | 454.1 | 379.7 |
| Average depth of ponds (inches) | 42 | 43 | 41 | 49 | 50 | 50 | 50 | 48 |
| Average turbidity of ponds (inches) | 14 | 13 | 38 | 49 | 12 | 12 | 25 | 15 |

*Comments*

This pond, fertilized with 10-20-0 fertilizer, had no vegetation problem. The number of bass harvested was the highest of all the ponds. Also, the plankton volume and plankton number were greater than in any of the other ponds.

HARVESTING DATA POND $C_2$

*Fish Production*

This pond was fertilized with 10-10-0 fertilizer and was drained on July 1, 7, 8, and 9. A total of 22,705 bass weighing 65.7 pounds and ranging in length from 1.8 inches to 3.9 inches were harvested. On June 18 a fish kill was observed in this pond. Many small fish were lying dead on the bottom. The cause of the kill was not known. No chemical data, such as pH, dissolved oxygen and dissolved carbon dioxide, had been determined up to this date. Forty-five pounds of shad ranging in length from 2½ inches to 3 inches were also harvested. This made a total of 110.7 pounds of fish that were harvested. Tables 2 and 4.

*Vegetation Growth*

There was very little submersed vegetation in this pond. It consisted of a few patches of Potamogeton pectinatus and Potamogeton americanus. The emergent vegetation consisted of a few patches of cattails, arrowheads and rushes in the shallow end of the pond only.

*Plankton Volume and Plankton Numbers*

The phytoplankton were more abundant in this pond than in Pond $C_3$ but the zooplankton were less abundant. The averages of all the samples taken of both the volume of plankton and number of plankton were as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 6.7 | 47,500 | 658,125 | 322,187 | 961,388* | 4,180,000 |

*Comments*

The average volume of plankton and the average number of zooplankton were less than in $C_3$, but the average number of phytoplankton was greater in $C_2$. There was no vegetation problem and hence no cutting of vegetation was required. The number of bass harvested was about half that of $C_3$, but the number of pounds of bass was greater in this pond, 65.7 pounds as compared with 52.6 pounds in $C_3$. A fish kill was also observed in this pond on June 18. The length range of the bass in this pond was slightly higher, 1.8 inches to 3.9 inches as compared with 1.2 inches to 3.6 inches in Pond $C_3$.

HARVESTING DATA POND $C_1$

*Fish Production*

This pond was fertilized with 10-0-0 fertilizer and was drained on July 9. The number of bass harvested was 13,195. They weighed a total of 66.8 pounds and

TABLE 3
*Vegetation growth*

| Ponds | Draining dates | Growth | Kinds of vegetation present |
|---|---|---|---|
| $C_3$ | June 24, 30 Fertilizer used 10-20-0 | No cutting of vegetation necessary. | Few patches of Potamogeton americanus and cattails in the shallow end. |
| $D_3$ | Aug. 8, 14, 20 Fertilizer used 10-20-0 | No cutting of vegetation necessary. | Few patches of Potamogeton americanus, cattails, rushes and smartweed. |
| $E_3$ | August 28 Fertilizer used 10-20-0 | The entire pond needed cutting because of an excessive growth. | Potamogeton americanus, P. pectinatus, cattails, sedges and smartweed. |
| $C_2$ | July 1, 9 Fertilizer used 10-10-0 | No cutting of vegetation necessary. | Few patches of Potamogeton americanus, P. pectinatus, rushes, cattails, sedges, smartweed and arrowhead. |
| $D_2$ | July 17, 22, Aug. 7 Fertilizer used 10-10-0 | Vegetation needed cutting only in the shallow end. | Najas, Potamogeton americanus, few cattails, rushes, sedges and the water net Alga, Hydrodictyon. |
| $E_2$ | Aug. 21, 27 Fertilizer used 10-10-0 | Growth of vegetation was excessive along the center. Cutting necessary. | Najas, Potamogeton americanus, sedges, smartweed and Hydrodictyon. |
| $C_1$ | July 9 Fertilizer used 10-0-0 | Entire pond needed cutting because of an excessive growth. | Najas, Potamogeton americanus, P. pectinatus, cattails, smartweed, sedges and burweed. Spirogyra. |
| $D_1$ | Aug. Fertilizer used 10-0-0 | Entire pond needed cutting because of an excessive growth. | Potamogeton pectinatus abundant, few patches of P. americanus, smartweed, arrowhead, rushes and Hydrodictyon. |
| $E_1$ | July 15, 16, 17 Fertilizer used 10-0-0 | Entire pond needed cutting because of an excessive growth. | Potamogeton pectinatus abundant, few patches of P. americanus, smartweed, arrowhead and Hydrodictyon. |

the length range was 2.0 inches to 6 inches. Also, 125 shad were taken from this pond. They weighed 25 pounds and ranged in length from 4 inches to 6 inches. The total pounds of shad and bass were 91.8. On June 18 a fish kill was also observed in this pond. See Tables 2, 4 for production data.

*Vegetation Growth*

There was considerable more vegetation in this pond; and two-thirds of the pond, beginning at the shallow end, required cutting. The vegetation included Potamogeton pectinatus and Najas and also included some filamentous Alga, Spirogyra. Table 3.

*Plankton Volume and Plankton Numbers*

There was a slight increase in the average volume and in the average number of plankton over that of Pond $C_2$, but less than that of Pond $C_3$ with the excep-

tion of the number of phytoplankton which was greater in this pond than in Pond $C_3$. The average number of plankton and the average volume of plankton were as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 8.82 | 119,388 | 635,500 | 330,972 | 999,375* | 2,949,285 |

*Comments*

Although the number of bass harvested in this pond was only about one-third of the number of bass harvested in Pond $C_3$, and only about one-half the number of bass harvested in Pond $C_2$, it produced more pounds of bass than either of these ponds. Also, the bass growth was greater with a length range of 2 inches to 6 inches. Also, 25 pounds of shad were taken from this pond, which represented the least number of pounds of undesirable fish taken from any of the ponds. Also, the total weight of all fish, 91.8 pounds, represented the least number of total pounds of fish harvested in any of the ponds. The vegetation was more abundant in this pond and required some cutting. The plankton numbers and volume compared quite favorably with the other ponds.

Therefore up to this date the best pond in this series in regard to the number of fish harvested, the best control of submersed vegetation and the abundance of plankton, was $C_3$ which was treated with 10-20-0 fertilizer. Pond $C_2$, treated with 10-10-0 fertilizer, was the next most desirable pond in the number of fish harvested and in the number of pounds of fish harvested.

HARVESTING DATA POND $E_1$

*Fish Production*

Pond $E_1$, treated with 10-0-0 fertilizer, was drained on July 15, 16 and 17. A total of 10,514 bass weighing 59.4 pounds and ranging in length from 2 inches to 5.3 inches, 220 pounds of shad from 4 inches to 6 inches in length and 2.5 pounds of carp were taken from this pond. This made a total of 281.9 pounds of fish. Dead bass 1½ inches in length, dead tadpoles and dead frogs were observed in this pond on June 18.

*Vegetation Growth*

The growth of submersed vegetation was excessive and required cutting the entire length of the pond. It included such forms as Najas, Potamogeton pectinatus, Potamogeton americanus and several patches of smartweed. The net Alga, Hydrodictyon, was also present on the surface of the water at the shallow end. Also, at the shallow end emergent forms of vegetation such as sedges and cattails were abundant.

*Plankton Volume and Plankton Numbers*

This pond was the third highest in the volume of plankton and it was the highest in the number of zooplankton. Of the latter the Rotifera were the most

numerous. The average volume of plankton and the average number of plankton forms were as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 8.68 | 56,750 | 571,250 | 1,056,250 | 1,551,363* | 1,182,500 |

*Comments*

A fish kill was observed in this pond on June 18. About 2,000 less bass were harvested in this pond as compared with those harvested in Pond $C_1$. The number of bass harvested in the other ponds of this series was below the number harvested in Ponds $C_3$ and $C_2$. The latter ponds produced 42,325 and 22,705 bass respectively. The growth of submersed vegetation was excessive in this pond and it required cutting.

HARVESTING DATA POND $D_2$

*Fish Production*

This pond was treated with 10-10-0 fertilizer and was drained on July 17, 22 and August 7. A total number of 22,010 bass weighing 96.8 pounds and ranging in length from 2.1 inches to 4.4 inches were harvested. Also, 85 pounds of shad ranging in length from 2 inches to 3 inches, and 123.7 pounds of carp from 10 inches to 11 inches in length were taken from this pond. The total number of pounds of bass, shad and carp harvested was 305.5 pounds. Tables 2 and 4.

*Vegetation Growth*

The growth of submersed vegetation was greater than in $C_2$ but not as great as in Ponds $C_1$ and $D_1$. It needed cutting only in the shallow end. The main kinds were Najas and Potamogeton. The emergent vegetation consisted of cattails and arrowhead, which were abundant at both the deep and the shallow ends of the pond. There was also present some of the net Alga, Hydrodictyon, on the surface of the water at the shallow end. Table 3.

*Plankton Volume and Plankton Numbers*

The volume and number of plankton were lower than in the other ponds of Series 2. However, the number of phytoplankton was greater. The average volume and the average number of each type were as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 4.84 | 56,000 | 547,000 | 268,000 | 806,818* | 1,219,500 |

*Comments*

The number of bass harvested was practically the same as that of Pond $C_2$, but the total pounds of bass was greater than in any of the ponds, a total of 96.8 pounds.

The vegetation growth was not too excessive and required cutting only in the shallow end of the pond.

The plankton volume and number of zooplankton were less than in any of the other ponds.

### HARVESTING DATA POND $D_3$

*Fish Production*

This pond was treated with 10-20-0 fertilizer and was drained on August 8, 14, and 20. A total of 19,000 bass weighing 78 pounds and ranging in length from 2 inches to 4.4 inches were harvested. Also, 2,000 carp weighing 280 pounds and 6 inches in length were taken from this pond. This makes a total of 358 pounds of fish harvested. The turbidity remained about the same during the entire summer, from 12 inches to 14 inches. The stirring of the mud on the bottom of the pond by the large number of carp present was probably a contributing factor to this turbidity.

*Vegetation Growth*

The growth of submersed vegetation was no problem; and no cutting was necessary. Only a few scattered patches of cattails were present. This pond compared favorably with Pond $C_3$ in the control of the growth of vegetation. Table 3.

*Plankton Volume and Plankton Numbers*

The average volume of plankton and the average number of plankton were the lowest of the Series 3 ponds, and they were also lower than any of the ponds of Series 1 and Series 2. These averages were as follows:

| Volume ml. | Number of Cladocera | Number of Copedpoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 3.25 | 28,000 | 348,000 | 278,000 | 605,909* | 844,375 |

*Comments*

This pond was quite turbid during the entire period. Although the number of bass was less than in Pond $C_3$, the number of pounds of bass was greater than that of the other two ponds of Series 3. The plankton volume and plankton number were the lowest of all the ponds. The vegetation was no problem.

### HARVESTING DATA POND $E_2$

*Fish Production*

This pond was drained on August 21 and on August 27. A total of 5,788 bass weighing 43.1 pounds and ranging in length from 2 inches to 5.3 inches were harvested. The number and pounds of bass harvested were less than were harvested in any of the other ponds. However, the number of ponds of carp and shad harvested was greater than in any of the other ponds, a total of 216 and 195

TABLE 4

*Fish production*

| Ponds | Fertilizer used | Number of Bass | Pounds of Bass | Total pounds of Bass, Shad and Carp | Harvesting Dates |
|---|---|---|---|---|---|
| $C_3$ | 10-20-0 | 42,325 | 52.6 | 112.6 | June 24, 30 |
| $C_2$ | 10-10-0 | 22,705 | 65.7 | 110.7 | July 1, 7, 8, 9 |
| $C_1$ | 10-0-0 | 13,195 | 66.8 | 91.8 | July 9 |
| $E_1$ | 10-0-0 | 10,514 | 59.4 | 281.9 | July 15, 16, 17 |
| $D_2$ | 10-10-0 | 22,010 | 96.8 | 305.5 | July 17, 18, Aug. 7 |
| $D_3$ | 10-20-0 | 19,000 | 78.0 | 358.0 | August 8, 14 |
| $E_2$ | 10-10-0 | 5,788 | 43.1 | 454.1 | August 21, 27 |
| $E_3$ | 10-20-0 | 6,738 | 61.7 | 379.7 | August 28 |

pounds respectively. Therefore, this pond was the first in total number of pounds of fish harvested which was 454.1 pounds. The carp ranged in length from 6 inches to 8 inches and they were quite active in stirring up the mud. This was especially true at the shallow end and along the dikes to the extent that depressions were made 4 inches below the normal level of the pond bottom, and ridges several inches deep were made in the dikes. Tables 2 and 4.

*Vegetable growth*

The growth of submersed vegetation was excessive along the center of the pond only, and required cutting only in this area. The sides of the pond were clear of vegetation. This may have been due to the method of applying the fertilizer by throwing it in from the dikes. In this way the sides of the ponds received a greater concentration of the fertilizer. The vegetation included Najas, Potamogeton americanus, sedges and a few patches of smartweed and Hydrodictyon. Table 3.

*Plankton Volume and Plankton Number*

The plankton volume and plankton number were about the same as that of the other ponds. The average was as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 5.28 | 15,850 | 543,500 | 482,650 | 951,363* | 470,000 |

*Comments*

The number of bass and the number of pounds of bass harvested were less than were harvested in any of the other ponds. The number of pounds of carp and shad harvested was greater than in any of the other ponds. Vegetation was abundant only in the center of the pond and required some cutting. The plankton abundance compared favorably with that of the other ponds.

### HARVESTING DATA POND $E_3$

*Fish Production*

This pond was drained on August 28, and it was the last pond drained. The number of bass harvested was 6,738. They weighed 61.7 pounds and weighed more per fish than did any of the bass from the other ponds. The length range was from 2 inches to 5.3 inches. Also, 116 pounds of shad and 202 pounds of carp were harvested. They ranged in length from 4 inches to 6 inches and 6 inches to 8 inches respectively. The total number of pounds of fish harvested was 379.7. Tables 2 and 4.

*Vegetation Growth*

The growth of submersed vegetation was the most excessive of all ponds. Channels had to be cut the entire length of the pond so that the fish could reach the kettle. The most abundant forms were Najas, Potamogeton americanus, Potamogeton pectinatus, cattails and sedges. There were also a few patches of smartweed. Table 3.

*Plankton Volume and Plankton Number*

The plankton volume and plankton number compared favorably with that of the best of the other ponds. The average was as follows:

| Volume ml. | Number of Cladocera | Number of Copepoda | No. of Ostracoda and Rotifera | Total No. of Zooplankton | Total No. of Phytoplankton |
|---|---|---|---|---|---|
| 6.64 | 41,500 | 455,250 | 753,250 | 1,110,863* | 2,718,125 |

*Comments*

This was the worst pond as to the growth of submersed vegetation. This was probably due to the fact that it was the last pond that was drained and therefore the vegetation had a longer growing period.

The number of bass harvested was next to the lowest, but they weighed more per fish than did any of the bass taken from the other ponds. The total number of pounds of fish was 379.7 pounds which was next to the highest number of pounds of fish harvested.

## CONCLUSIONS

*Vegetation Control*

1. The series of ponds with the least growth of submersed vegetation was the series treated with 10-20-0 fertilizer. Only Pond $C_3$ of this series required cutting. However, this pond had a greater abundance of submersed vegetation than any pond of the other series. A four weeks longer growing period was one of the important factors in this increased growth. Table 3.

2. The next best series of ponds, showing the least growth of submersed vegetation, was the series treated with 10-10-0 fertilizer. However, all but one pond, $C_2$, of this series required cutting of the vegetation. Pond $D_2$ required cutting

only in the shallow end; and the vegetation in Pond $E_2$ required cutting only along the entire center of the pond. Table 3.

*Turbidity*

1. The ponds with the greatest turbidity were those of Series 3 and Series 2. These series had an average turbidity of 13.6 inches and 16.6 inches, respectively. The decomposition of submersed vegetation was probably the greatest contributing factor to this turbidity rather than a plankton bloom, since these series had the least plankton volume.

2. The average turbidity in the ponds of Series 1 was 43.5 inches. Tables 5 and 6.

*Bass Production*

1. The ponds that produced the greatest number of bass were the ponds of Series 3 and Series 2, with the exception of Ponds $E_3$ and $E_2$. The average numbers for Series 3, Series 2 and Series 1 were 22,687, 16,834 and 11,854 respectively. Tables 4 and 6.

2. The ponds that produced the greatest number of pounds of bass were Ponds $D_2$, $D_3$ and $C_1$ respectively, one from each of the three series. Note that Pond $C_3$, which produced the greatest number of bass, was next to the last in the number of pounds of bass. Table 4.

3. Based on the average number of pounds of bass for each series, Series 2 and Series 3 were first and second with 68.5 pounds and 64.1 pounds, respectively. Series 1 was last with 63.1 pounds. Table 6.

*Total Fish Harvested*

1. Based on the average number of pounds of fish harvested, ponds of Series 2 and Series 3 were first and second with 290.1 pounds and 283.4 pounds of fish, respectively. Series 1 was last with 186.8 pounds. Note that the ponds that were drained last produced the greatest number of pounds of fish. Tables 4 and 6.

TABLE 5

*Averages of plankton volume and plankton numbers*

| | | RATINGS | | | | |
|---|---|---|---|---|---|---|
| Averages | Series 3 | Rating | Series 2 | Rating | Series 1 | Rating |
| Plankton volume in ml. | 7.26 | Second | 5.6 | Third | 8.75 | First |
| Number of zooplankton | 1,012,090 | Second | 906,523 | Third | 1,275,369 | First |
| Number of phytoplankton | 1,957,500 | Second | 1,956,500 | Third | 2,065,892 | First |
| Total number of plankton | 2,969,590 | Second | 2,863,023 | Third | 3,341,261 | First |
| Turbidity (inches) | 13.6 | Greatest | 16.6 | Next greatest | 43.5 | Least |
| Pond depth (inches) | 46 | Second | 47 | First | 45 | Third |

TABLE 6

*Summary of fish and plankton production and vegetation control*

| Fertilizer | 10-20-0 | | 10-10-0 | | 10-0-0 | |
|---|---|---|---|---|---|---|
| Averages | Series 3 | Rating | Series 2 | Rating | Series 1 | Rating |
| Number of bass | 22,687 | First | 16,843 | Second | 11,854 | Third |
| Number of pounds of bass | 64.1 | Second | 68.5 | First | 63.1 | Third |
| Number of pounds of fish | 283.4 | Second | 290.1 | First | 186.8 | Third |
| Volume of plankton | 7.26 | Second | 5.6 | Third | 8.75 | First |
| Number of zooplankton | 1,012,090 | Second | 906,523 | Third | 1,275,369 | First |
| Number of phytoplankton | 1,957,500 | Second | 1,956,500 | Third | 2,065,892 | First |
| Number of plankton | 2,969,590 | Second | 2,863,023 | Third | 3,341,261 | First |
| Vegetation control | Two ponds free of veg. | First | One pond free of veg. | Second | No ponds free of veg. | Third |
| Turbidity (inches) | 13.6 | Greatest | 16.6 | Second | 43.5 | Least |
| Pond depth (inches) | 46 | Second | 47 | First | 45 | Third |

*Plankton Production*

The averages of the volume of plankton and the number of plankton in each series are given in Table 5.

The averages of volume of plankton, number of phytoplankton and zooplankton and number of all plankton were greater in the ponds of Series 1 than were these averages in the ponds of Series 3 and Series 2. Ponds of Series 3 were second in the averages of volume of plankton, and number of plankton. Ponds of Series 2 were third in volume of plankton and number of plankton. It is interesting to note that the ponds of Series 1 had the least turbidity of the ponds of the three series. The average turbidity disc reading for Series 1 was 43.5 inches as compared with 13.6 and 16.6 inches of Series 3 and Series 2 respectively. Hence, a greater turbidity is not always due to a greater abundance of plankton. Turbidity may also be due to a decomposition of vegetation, a stirring up of the mud by carp, or to both of these factors. Both of these factors along with plankton were probably the cause of the excessive turbidity in the ponds of Series 3 and Series 2.

*Summary*

1. The best fertilizer for the control of submersed vegetation was 10-20-0.
2. The ponds of Series 2 treated with 10-10-0 fertilizer produced the least number of plankton.

3. Ponds of Series 1 treated with 10-0-0 fertilizer produced the greatest volume of plankton and the greatest number of plankton.

4. The ponds of Series 2 produced the greatest number of pounds of bass. These ponds were fertilized with 10-10-0 fertilizer.

5. The ponds of Series 3 treated with 10-20-0 fertilizer produced the greatest number of bass.

6. Ponds of Series 2 treated with 10-10-0 fertilizer produced the greatest number of pounds of fish.

*Ratings*

Ponds of Series 3 treated with 10-20-0 fertilizer were first in the number of bass harvested and were also first in the control of submersed vegetation. Ponds of Series 2 were first in the number of pounds of bass and the number of pounds of fish harvested, and were second in the control of submersed vegetation. Ponds of Series 1 were first in volume and number of plankton but had the lowest turbidity. Ponds of Series 3 were second in volume and number of plankton but had the greatest turbidity, which was 13.6 inches. Table 6.

# A PUNCHED CARD SYSTEM FOR CATALOGING A GENERAL BIBLIOGRAPHY IN BIOLOGY

ROBERT W. ALRUTZ†

Biologists have always been burdened with problems of maintaining expansive bibliographies, files of abstracted materials, records and data. With recent world-wide proliferation of both separate and serial publications the problem has become even more critical, so critical that it is being studied by groups at the national level. Various systems and solutions are evidenced. Probably the most publicized and most flexible is that utilizing the familiar IBM card and associated equipment produced by the International Business Machines Corporation. Such a system is on one hand extremely convenient, even being capable of typing out a complete bibliography, but on the other highly impractical. The extremely high cost of equipment limits these systems to the larger organizations and, even here, almost precludes their use by the independent investigator. Further, should the investigator move to a new position he may find that an IBM machine is not available.

For a number of years research personnel in the physical sciences have been utilizing systems designed for marginal punched cards. Such a card requires only the minimum of hand equipment for basic operation and yet its use may be facilitated by the addition of various machines. It can not, however, be utilized to the high degree available with the very flexible IBM machine. The main advantage of the marginal punched card is the simplicity and low cost of operation. The individual investigator needs only a punch or two and several needles to initiate the system. Marginal punched cards are available from several manufacturers in many styles. They range in size from 3 by 5 inches to letter size and can be procured in stocks of different quality. The punching may be single row or double row four or five holes to the inch. These cards are available with various printed codes, divisions or special systems, some being especially designed for bibliographic filing. Further, any desired system will be printed by the manufacturer or may be added by the investigator himself.

Biologists have only recently begun to utilize this technique and hence there is not available a set procedure or universal system. Those systems which have been designed reflect the special needs of the investigators, a characteristic undoubtedly inherent within the limitations of the cards. My own personal demands called for a system suitable for both general bibliographic references and special bibliographies and data files. A review of published material yielded suggestions; but it was early seen that none could be used unaltered for the desired system. Therefore, after conference with a manufacturer's representative a system was designed.

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Marginal punched cards lend themselves to certain basic techniques built around the principle that a punched hole will allow a card to drop from the pack when a sorting needle is passed through that hole. The number of holes available is naturally limited by the size of the card and the number of holes per inch. However, by use of numerical or letter codes this limited number of holes may be used for a large number of categories.

There are two basic techniques that may be utilized:

*Direct Categories*, or direct coding, in which each hole is assigned a single category. This offers the advantage that on one card any or all of the holes may be punched thus indicating multiple items. For instance, were one to assign the categories Taxonomy, Anatomy, Physiology, and Embryology to a series of four holes it would be possible to indicate that the reference contained material relative to any one or combination of these. Use of direct categories is, however, limited by the number of available holes. In most systems direct categories are utilized only for broader subject areas.

*Indirect coding* is built upon the principle of a code of numbers or letters. The latter is often utilized to indicate the author, or authors. Such a system utilizes a unique code involving five holes designated as O-I-E-C-B. By using various combinations of these, any letter of the alphabet may be indicated and, by using three sets, the first three letters of an author's name may be coded. A numerical code is structured on a standard set of four holes numbered 7-4-2-1. By combining these any digit from 1 to 9 may be indicated and with use of additional sets the tens, hundreds and thousands. Variations of this basic pattern exist, utilizing additional holes or a second row of holes to indicate whether it is a single number (4) or a number formed by a combination (4 + 1 to indicate 5) or even to indicate the cipher. These latter techniques are advantageous during sorting but naturally utilize additional holes and require additional punching.

All codes are beset with one major limitation—only one item may be indicated within the code on any one card. Thus in the following code to Geographic Distribution if one were to punch 1110 to indicate the Northeastern States he could not punch any other geographic distribution. If the paper were to deal with three geographic areas (three states for instance) it would be necessary to use the next highest category (region) or to make three separate cards, one for each state.

## BASIC PROBLEMS

In designing a system, therefore, one must keep in mind certain basic problems.

1. To use direct categories where the number of items is not too large and where these are likely to overlap in any given reference.
2. To code all items occurring in long series:
   a. To use, where possible, numbers that do not require combinations (7, 4, 2, 1).
   b. To design the code so that higher numbers will group lower numbers into categories. Thus, all 100 numbers in the following Geographic Distribution indicate the United States and all 1,000 numbers North America.
   c. To allow for expansion or the insertion of unforseen categories.

## CATEGORIES

The actual material to be included will naturally depend upon the needs of the investigator, but it must be adapted to the limitations of the basic pattern of marginal punched cards. One must consider the system two ways, what data must be filed, and in what ways should it be recoverable. The usual bibliographic notations are considered first.

*Author.* Author designation is usually deemed worthy of coding so that the reference may be located if the author is known. Also, this will permit alphabetizing the total file or any extracted part of it.

*Date of publication.* This may be indicated with nine or ten holes and is considered useful in compiling chronological sequences. Thus, if one wishes to review literature published since any given date the cards may be readily separated. It is also useful in arranging long bibliographies of a given author.

*Title of reference.* The actual title can not readily be indicated. However, the content may be included under the classification given below.

*Publisher* or *Periodical.* This is a rather debatable item as far as coding is concerned. A method for indicating such has been included in this system so that it will be possible to make maximum use of library time and services. The author is compelled to use distant libraries and interlibrary loan and to make decisions relative to purchase of serial publications. By indicating the publication, and by use of the date, it is possible to sort out those materials published in a given periodical and to arrange them in sequence approximating volume number.

*Content or Classification.* At this point the needs of the researcher dictate what categories are to be considered and the method of treatment. For the purposes of the system under consideration three categories have been used but this in no wise should be construed as all inclusive or limiting.

1. *Geographic Distribution* is coded for each reference so that the geographic coverage of the material may be indicated. This has been set up so that North American designations are in more detail, that being the region of greatest concern.

2. *Taxonomic* classification is allowed for. Being a general system, the classification includes both Plant and Animal Kingdoms and is broken down only to Class in the Plant Kingdom and Order in the larger groups of the Animal Kingdom. Were one to desire a more detailed system for a restricted group it could be constructed even to species. The following has been designed as a numerical code with the assignment of numbers to each category. Space has been allowed for expansion. An attempt was made to follow the system proposed by Denmark, *et al.*, 1958. Their system, however, is designed for the IBM machine which apparently permits a more expansive code. Their proposal requires a 16 digit code which on marginal punched cards would demand a minimum of 64 holes. The standard 5 by 8 inch marginal punched card has only 91 holes, thus use of such a system would greatly restrict any other classification on the card. The code here included utilizes 13 holes and may be expanded to more, thus allowing for a minimum of 1,999 categories. One could easily expand this to suit special needs. Or, by allowing four more holes, each assigned category could be broken down

into 10 decimal places. The open-ended code proposed by Denmark, *et al.*, 1958, obviously has many advantages but it calls for $10^{15}$ categories to classify less than 2 million organisms. Marginal punched cards do not allow such extravagance.

*Subject Matter.* Again each researcher must make his own decision in regard to categories used. The material should be considered as to the normal classification utilized for such material, but more important, decision should be made as to how this information should be classified relative to the needs of the investigator. In other words, what does he want to get out of the file? This is perhaps the most critical area of the system and must be studied thoroughly. The author feels that this must be indicated as Direct Categories as contrasted to any Code because of the very nature of publications. Consider for a moment the number of cross-references in the normal library card catalogue.

*Abstracted Material.* The foregoing discussion has dealt only with the edge of the card, that pre-punched for coding. The researcher has at his disposal the center of the card, and the reverse side. These areas may be utilized for any information, coded or otherwise, that is relevant to the reference. Abstracted information, or an actual copy of a printed abstract, may be placed thereon. Levine (1955) recommends attaching abstracts cut from Biological Abstracts, a seemingly commendable system. On larger cards more expansive data may be recorded. For recording specific data in long Direct Category sequences the center of the card may be printed for punching and thus data indicated therein. Such a card has been described by Byer, *et al.*, 1959, and is available from Royal Macbee Company under the number M.S.U.-BOT (G231*5). The card has 350 numbered spaces, each of which may be assigned a category. The cards cannot be sorted for these categories in the usual manner, but punching does offer advantages over listing such data.

## MARGINAL PUNCHED CARDS AND TECHNIQUES

*The Card.* Once the basic system is designed it must be fitted to an available or specially designed card. Items to be considered here are:

1. *Size.* The size of the card must be governed by the number of holes required or the amount of space needed for abstracted material. Most researchers seem to prefer a 5 by 8 inch card though many find a 3 by 5 inch card adequate. Larger cards are probably unsatisfactory because of storage problems or cost.

2. *Style.* The main consideration here is whether there should be double or single rows of holes or some of each. This must be decided by the demands of the system, the size of card chosen and the cost.

Printing also varies, though this may be arranged with the supplier or done locally by the researcher. Some have even found mimeographing satisfactory. Variations within the system may be achieved by utilizing cards with different cloored top edges. Also, by varying the position of the "clipped" corner or by cutting off additional corners, it is possible to quickly sort for these.

3. *Storage.* This is not a major consideration, for such files are not used in the same manner as conventional files. Cards are not "filed" but merely stored. During sorting they are removed from the storage facility and stacked on the

desk or table. Thus, any sort of container, even the shipping box of the supplier, will suffice. However, the popularity of 3 by 5 inch and 5 by 8 inch cards perhaps indicates the desirability of utilizing pre-existing filing facilities.

4. *Cost.* Though less expensive than a machine-sorting system, marginal punched cards are not cheap. They are economical in time, not material. Cost depends upon the rag content of the stock, size of card, style of punching and amount of printing. Special printing involves a rather high initial outlay and special ordering.

Cost can also be reduced by purchasing in larger lots, the cost per additional 1,000 cards dropping rather rapidly.

*Technique.* The marginal punched card is most valuable in retrieving information. This does present the problem of inserting new materials and ascertaining what is already in the file. Usually such files are not kept in any set order, thereby relieving the investigator of the filing chore. This, however, demands that some system be used to ascertain what is in the file. The author finds it necessary to continue the normal bibliographic file on 3 by 5 inch cards. These are retained in an alphabetical arrangement. Incomplete references are always readily accessible for addition of information. When the reference is complete it is then typed in a punched card, coded and added to the file. The original reference card is stamped to indicate that it is included within the file.

### A PUNCHED CARD SYSTEM APPLICABLE TO GENERAL BIOLOGY

*Card.* This system is built around a card 3¼ by 7½ inches in size, with five holes to the inch for a total of 101 holes. The card used is manufactured by the Royal McBee Corporation and bears the number K5S371N. Being a standard card used in large number by industry, and having a lower rag content, its cost is only one-third that of the average 5 by 8 inch card. A zinc plate was procurred to print the inserted material. (See Plate 1.)

*Author Code.* This system uses 1,000 alphabetical sub-divisions as published

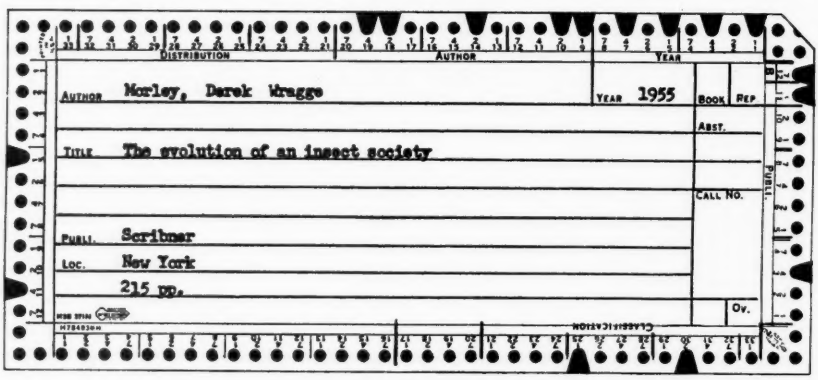


PLATE 1. Sample Card. Actual size 3¼ × 7½ inches. Punched according to codes established in this paper.

by the Royal McBee Corporation, providing an excellent breakdown with only 12 holes. The system has been designed by professional indexers and resembles those used in library card catalogues.

*Date of Publication* is indicated to decade and year in eight holes. For 19th century dates a ninth hole is punched and those few 18th century references are indicated by punching a spare hole at the upper-right corner. For twentieth century dates only the year and decade are punched.

*Publications.* As indicated previously the author must be able to sort for publication source. Twelve holes have been allocated for coding the Periodical or Publisher. One additional hole is utilized to distinguish between periodicals (hole punched) and separate publications (not punched). Publishers are indicated by use of a 500 category alphabetical subdivision as for the author indication. Periodicals, however, due to similarity of names, are assigned code numbers. The available holes allow for 1,000 categories which have been assigned to periodicals as given in "A list of abbreviations of the titles of Biological Journals." This list contains the titles and abbreviations thereof for 388 serial publications important in biological research. It is not an exhaustive list; many frequently used titles are missing, such as "The Ohio Journal of Science." However, this is of little consequence for the cataloguer can easily insert those unique to his discipline. The author has assigned numbers directly to this list, leaving every tenth number unassigned. This allows for adding such titles. Where this proves insufficient, titles not important to the investigator may be replaced by other, more appropriate titles.

*Geographic Distribution.* The following numerical code to geographic regions of the world has been constructed from various sources. The subdivisions of the United States were extracted from the Dewey Decimal System. The bulk of the remainder is a modification of the categories listed under Geographic Distribution (Plants) by the Library of Congress. This in turn was amended and enlarged with political subdivisions of Mexico, Canada and parts of Africa as given in Webster's Geographic Dictionary.

Code numbers were assigned so as to facilitate recovery of material relative to the United States. The 100 hole will separate all United States' materials. By the same token each decile is assigned to a region and the states therein. Special areas are likewise designated.

All North American regions may be separated out with the 1,000 hole. Once the North American material is separated the remaining material may be divided into major areas by using the 200 hole which will separate out the 600 and 900 categories as one stack, leaving the 400 and 700 in the other stack. These two stacks are then further divided by using either the 400 or 700 hole. Thus, three separations will break the material into approximately continental regions.

*Taxonomic Categories.* For the purposes of this system a general classification was desired. The following classification was compiled from various introductory textbooks in Biology. Admittedly the classification is not complete, only the major categories being represented. However, additional categories may be subsequently assigned to the unused numbers. Also, the Taxonomic Classifica-

tion utilized does not necessarily represent the most recent opinions of systematists. The question arises as to when the conversion to a more up-to-date system should take place. Older literature is classified basically according to this system; and it will be used for some time. If a more systematically correct classification were adopted it would mean a reclassification of older literature. Hence the problem exists; and the author chose to utilize a system with which he is more familiar.

By utilizing thirteen holes it was possible to construct a system that mixes the advantages of direct categories with the breadth of a code. Thus each of the five highest numbers separates a major group: 1,000 for the Plant Kingdom; 700 for Protozoa; 100 for Chordates; 200 for Arthropods; and 400 for the remaining animal Phyla. No combination numbers were used. Where possible, deciles were assigned to include lesser groups. For example, 130 was assigned to Class Reptilia and 131 to 139 to its Orders and Suborders. In addition to Taxonomic categories vernacular names for certain groups have been indicated in the system.

*Subject Matter.* In the following list of Direct Categories each subject is assigned to an individual hole. An attempt has been made to include both pure and applied aspects. These categories are admittedly broad; but when combined with the taxonomic classification they should serve amply for a general classification. Spare holes are reserved for additional categories or in case some of these broader groups need to be broken down.

*Miscellaneous.* The various spaces on the right side of the face of the card are utilized for special indications.

1. The blocks indicating "Book" and "Rep." are utilized to indicate whether the author has a copy of the publication in his library or reprint file.
2. The abstract block is punched if the publication has been abstracted by the author; and the space beneath it is used to indicate the source of a published abstract.
3. The space for a call number is utilized for those materials in the University library.
4. The small square "over" is checked if data are placed on the reverse face of the card.

*Adaptation to Specialized Research.* The author is currently adapting this system to a file devoted to the Order Odonata, Class Insecta. This has necessitated only a more specialized set of Direct Categories of subject matter and a numerical code of Taxonomic classification. The latter necessitates the utilization of four additional holes to allow for the near six thousand categories included within this Order.

## GEOGRAPHICAL DISTRIBUTION

1000 North America—America

1100 United States

| | | | |
|---|---|---|---|
| 1110 | Northeastern States | 1160 | South Central States |
| 1111 | Maine | 1161 | Alabama |
| 1112 | New Hampshire | 1162 | Mississippi |
| 1113 | Vermont | 1163 | Louisiana |
| 1114 | Massachusetts | 1164 | Texas |
| 1115 | Rhode Island | 1165 | Oklahoma |
| 1116 | Connecticut | 1166 | Arkansas |
| 1117 | New York | 1167 | Tennessee |
| 1118 | Pennsylvania | 1168 | Kentucky |
| 1119 | New Jersey | | |
| 1120 | Southeastern States | 1190 | Western States |
| 1121 | Delaware | 1191 | Kansas |
| 1122 | Maryland | 1192 | Nebraska |
| 1123 | District of Columbia | 1193 | South Dakota |
| 1124 | West Virginia | 1194 | North Dakota |
| 1125 | Virginia | 1195 | Montana |
| 1126 | North Carolina | 1196 | Wyoming |
| 1127 | South Carolina | 1197 | Colorado |
| 1128 | Georgia | 1198 | New Mexico |
| 1129 | Florida | | |
| 1140 | North Central States | 1170 | Far Western States |
| 1141 | Ohio | 1171 | Arizona |
| 1142 | Indiana | 1172 | Utah |
| 1143 | Illinois | 1173 | Nevada |
| 1144 | Michigan | 1174 | California |
| 1145 | Wisconsin | 1175 | Oregon |
| 1146 | Minnesota | 1176 | Idaho |
| 1147 | Iowa | 1177 | Washington |
| 1148 | Missouri | 1178 | Alaska |
| | | 1179 | Hawaii |

### SPECIAL AREAS

| | | | |
|---|---|---|---|
| 1149 | Great Lakes | 1109 | Eastern United States |
| 1191 | Great Plains | 1110 | New England |
| 1102 | Rocky Mountains | 1199 | Western United States |
| 1104 | National Parks/Refuges | 1169 | Gulf Coast |
| 1107 | Deserts | 990 | Arctic (including Greenland) |

UNITED STATES BY ALPHABETICAL ARRANGEMENT

1161 Alabama
1178 Alaska
1171 Arizona
1166 Arkansas
1174 California
1197 Colorado
1116 Connecticut
1121 Delaware
1123 District of Columbia
1129 Florida
1128 Georgia
1179 Hawaii
1176 Idaho
1143 Illinois
1142 Indiana
1147 Iowa
1191 Kansas
1168 Kentucky
1163 Louisiana
1111 Maine
1122 Maryland
1114 Massachusetts
1144 Michigan
1146 Minnesota
1162 Mississippi
1148 Missouri
1195 Montana
1192 Nebraska
1173 Nevada
1112 New Hampshire
1119 New Jersey
1198 New Mexico
1117 New York
1126 North Carolina
1194 North Dakota
1141 Ohio
1165 Oklahoma
1175 Oregon
1118 Pennsylvania
1115 Rhode Island
1127 South Carolina
1193 South Dakota
1167 Tennessee
1164 Texas
1172 Utah
1113 Vermont
1125 Virginia
1177 Washington
1124 West Virginia
1145 Wisconsin
1196 Wyoming

CANADA

1200 Canada
1201 Alberta
1202 British Columbia
1204 Manitoba
1207 New Brunswick
1210 Newfoundland (and Labrador)
1211 Northwest Territories
1212 Nova Scotia
1214 Ontario
1216 Prince Edward Is.
1217 Quebec
1218 Saskatchewan
1219 Yukon Territory

MEXICO

| | | | |
|---|---|---|---|
| 1220 | Mexico | 1240 | Nuevo León |
| 1221 | Aguascalientes | 1241 | Oaxaca |
| 1222 | Campeche | 1242 | Puebla |
| 1223 | Chiapas | 1243 | Querétaro |
| 1224 | Chihuahua | 1244 | San Luis Potosi |
| 1225 | Coahuila | 1245 | Sinaloa |
| 1227 | Durango | 1247 | Sonora |
| 1228 | Federal District | 1248 | Tabasco |
| 1229 | Guanajuato | 1250 | Tamaulipas |
| 1230 | Guerrero | 1251 | Tlaxcala |
| 1231 | Hidalgo | 1252 | Veracruz |
| 1232 | Jalisco | 1253 | Yucatan |
| 1233 | México | 1254 | Zacatecas |
| 1234 | Michoacán | 1256 | Lower California (North) |
| 1235 | Morelos | 1257 | Lower California (South) |
| 1237 | Nayarit | 1258 | Quintana Roo |

CARIBBEAN

| | | | |
|---|---|---|---|
| 1260 | West Indies | 1265 | Jamaica |
| 1261 | Bahamas | 1267 | Puerto Rico |
| 1262 | Cuba | 1269 | Bermudas |
| 1264 | Haiti | | |

SOUTH AMERICA

| | | | |
|---|---|---|---|
| 1270 | South America | 1279 | Guiana, Dutch |
| 1271 | Argentina | 1280 | Guiana, French |
| 1272 | Bolivia | 1281 | Paraguay |
| 1274 | Brazil | 1282 | Peru |
| 1275 | Chile | 1284 | Uruguay |
| 1276 | Colombia | 1287 | Venezuela |
| 1277 | Ecuador | 1288 | Falkland Is. (et al.) |
| 1278 | Guiana, British | 1289 | Atlantic Is. (Azores, etc.) |

EUROPE

400 Europe
401 Alpine
402 Others
410 Great Britain, England
411 Ireland
412 Scotland
414 Wales
420 Austria, Hungary
421 France, Riviera, Monaco
422 Germany
424 Greece
427 Italy, Malta
430 Netherlands (Low Countries)
431 Belgium
432 Luxemburg
434 Netherlands (Holland)
440 Russia
458 Poland
459 Finland
460 Scandinavia. General (Lapland)
461 Denmark
462 Iceland
464 Norway
467 Sweden
470 Spain and Portugal (Iberian Pen.)
471 Spain
474 Portugal
425 Switzerland
480 Turkey and Balkans
481 Bulgaria
482 Montenegro
483 Rumania
487 Serbia

ASIA

600 Asia
601 Afghanistan
602 Arabia
603 Baluchistan
604 China
620 India
637 Pakistan, East
638 Pakistan, West
639 Ceylon
640 Indochina. Malay Peninsula
650 French Indochina
657 Siam
658 Straits Settlements
660 Indonesia. Malay Archipelago
667 Dutch East Indies
670 Philippine Islands
674 Japan
677 Korea
679 Persia
680 Russia in Asia
687 Siberia
690 Asia Minor. Turkey in Asia
691 Armenia
692 Palestine
694 Syria, Lebanon

AFRICA

700 Africa
710 Abyssinia (with Ethiopia)
711 Algeria and Tunis
714 Anglo-Egyptian Sudan
715 Angola
716 Ashanti
717 Bechuanaland
720 Belgian Congo
721 British Somaliland
722 Cameroons
723 Cameroun
724 Canary Islands
725 Cape Verde Islands
754 East Africa (Kenya)
727 Egypt
728 Eritrea
730 Ethiopia (and Abyssinia)
731 French Equatorial Africa
732 French Somaliland
740 French West Africa
741 Dahomey
742 French Guinea
743 French Sudan
744 Ivory Coast
745 Mauritania
746 Niger
747 Senegal
750 Gambia
751 Gold Coast
752 Guinea
753 Italian Somaliland
754 Kenya (East Africa)
757 Liberia
758 Libia (Tripoli)
760 Madagascar
761 Morocco
763 Mozambique
764 Nigeria
767 Northern Rhodesia
770 Northern Territories
771 Nyasaland
772 Principe Is.
773 São Tomé Is.
774 Sierra Leone
777 Southern Rhodesia
778 Spanish Guinea
779 Spanish Sahara
780 Tanganyika Territory
781 Togo
782 Togoland
758 Tripoli (Libia)
784 Tunisia
787 Uganda
790 Union of South Africa
791 Cape of Good Hope
792 Natal
794 Orange Free State
797 Transvaal
789 Zanzibar

AUSTRALIA AND PACIFIC

900 Australia
910 New South Wales
920 New Zealand and adjacent islands
930 North Australia. Northern Territory
935 Queensland
940 South Australia
944 Tasmania
950 Victoria
954 Western Australia
970 Pacific Islands
971 General—Individual numbering by island and group of islands
990 Arctic including Greenland
991 Antarctic

## TAXONOMIC CLASSIFICATION

### ANIMAL KINGDOM

100 Phylum Chordata
101 Subphylum Hemichordata
102 Subphylum Urochordata
103 Subphylum Cephalochordata (Acrania)
104 Subphylum Vertebrata (Craniata)
105 Superclass Pisces (Ichthyology)
106 Class Agnatha
107 Subclass Petromyzontia
108 Subclass Myxinoidea
109 Class Chondrichthyes
110 Subclass Elasmobranchii
111 Order Selachii
112 Order Batoidei
113 Subclass Holocephali
114 [Fishes] [Aquarium Fish]
115 Class Osteichthyes
116 Subclass Choanichthyes
117 Subclass Actinopterygii
118 Superorder Chondrostei
119 Superorder Holostei
120 Superorder Teleostei
121 Superclass Tetrapoda
122 [Herpetology]
123 Class Amphibia
124 Order Apoda
125 Order Urodela
127 Order Amura (Salientia)
130 Class Reptilia
131 Order Testudinata
132 Order Squamata
134 Suborder Sauria (Lacertilia)
137 Suborder Serpentes (Ophidia)
138 Order Crocodilia
139 Order Rhynchocephalia
140 Class Aves [Birds]
141 Order Struthioniformes
142 Order Rheiformes
143 Order Casuariiformes
144 Order Apterygiformes
145 Order Tinamiformes
146 Order Sphenisciformes
147 Order Gaviiformes

148 Order Colymbiformes
149 Order Procellariiformes
150 Order Pelecaniformes
151 Order Ciconiiformes
152 Order Anseriformes [Migrating Wild Fowl]
153 Order Falconiformes
154 Order Galliformes [Game Birds]
155 Order Gruiformes
156 Order Charadriiformes
157 Order Columbiformes
158 Order Psittaciformes
159 Order Cuculiformes
160 Order Strigiformes
161 Order Caprimulgiformes
162 Order Apodiformes
163 Order Coliiformes
164 Order Trogoniformes
165 Order Coraciiformes
166 Order Piciformes
167 Order Passeriformes [Song Birds]
168 [Bird Nests]
169 [Bird Eggs]
170 Class Mammalia
171 Subclass Prototheria
172 Subclass Theria
174 Infraclass Metatheria
176 Infraclass Eutheria
177 Order Insectivora
178 Order Dermoptera
179 Order Chiroptera
180 Order Primates
181 Order Edentata
182 Order Pholidota
183 Order Lagomorpha
184 Order Rodentia
185 Order Cetacea
186 Order Tubulidentata
187 Order Carnivora
188 Order Proboscidea
189 Order Hyracoidea
190 Order Sirenia
191 Order Perissodactyla
194 Order Artiodactyla
197 [Animal Tracks]
198 [Animal Homes]

200 Phylum Arthropoda
201 Class Crustacea
202 Subclass Branchiopoda
203 Subclass Ostracoda (& Cephalocarida)
204 Subclass Copepoda
205 Subclass Cirripedia
206 Subclass Malacostraca
203 Subclass Cephalocarida (with Ostracoda)
207 [Myriapoda]
208 Class Chilopoda
209 Class Diplopoda
210 Class Insecta
Subclass Apterygota
211 Order Protura
212 Order Thysanura
213 Order Collembola
Subclass Pterygota
Division Hemimetabola
214 Order Orthoptera
215 Order Dermaptera
216 Order Plecoptera
217 Order Isoptera
218 Order Embioptera
219 Order Ephemeroptera
220 Order Odonata
221 Order Anoplura
222 Suborder Siphunculata
224 Suborder Mallophaga
225 Order Corrodentia
230 Order Hemiptera
231 Suborder Heteroptera
232 Suborder Homoptera
233 Order Thysanoptera
Division Holometabola
234 Order Neuroptera
235 Order Mecoptera
236 Order Trichoptera
237 Order Coleoptera
240 Order Lepidoptera
241 [Moths]
242 [Butterflies]
244 Order Diptera
245 Order Siphonaptera
246 Order Strepsiptera
247 Order Hymenoptera
248 [Ants]

249 [Bees]
250 [Honey Bee]
251 [Bumble Bees]
252 [Galls]
270 Class Arachnoidea
271 Subclass Merostomata
271 Order Xiphosura
272 Subclass Arachnida
273 Order Scorpionida
274 Order Pedipalpi
275 Order Palpigrada
276 Order Pseudoscorpionida
277 Order Araneae
278 Order Solpugida
279 Order Phalangida
290 Order Acarina [Acarology]
291 [Mites]
292 [Ticks]
294 Subclass Pycnogonida
299 Phylum Brachiata
400 Phylum Tardigrada
401 Phylum Linguatulida
402 Phylum Onychophora
403 Phylum Chaetognatha
404 Phylum Echinodermata
405 Class Asteroidea
406 Class Ophiuroidea
407 Class Echinoidea
408 Class Holothuroidea
409 Class Crinoidea
410 Phylum Mollusca
411 Class Amphineura
412 Class Cephalopoda
413 Class Scaphopodoa
414 Class Gastropoda
415 Class Pelecypoda
416 Class Monoplacophora
417 [Sea Shells]
420 Phylum Annelida
421 Class Archiannelida
422 Class Polychaeta
424 Class Oligochaeta
427 Class Hirudinea
428 Phylum Priapuloidea
429 Phylum Echiuroidea
430 Phylum Sipunculoidea

431 Phylum Phoronidea
432 Phylum Brachiopoda
433 Phylum Bryozoa
434 Phylum Entoprocta
436 [Helminthology]
437 Phylum Aschelminthes
438 Class Nematoda
439 Class Nematomorpha
440 Class Rotifera
441 Class Gastrotricha
442 Class Kinorhyncha or Echinodera
444 Phylum Acanthocephala
447 Phylum Nemertinea
449 Phylum Mesozoa
470 Phylum Platyhelminthes
471 Class Turbellaria
472 Class Trematoda
473 Subclass Monogenea
474 Subclass Digenea
477 Class Cestoda
450 Phylum Ctenophora
454 Phylum Coelenterata or Cnidaria
457 Class Hydrozoa
462 Class Scyphozoa
467 Class Anthozoa
468 Subclass Alcyonaria
469 Subclass Zoantharia
490 Phylum Porifera
491 Class Calcarea
492 Class Hexactinellida
494 Class Demospongiae
700 Phylum Protozoa
710 Class Flagellata
720 Class Sarcodina
740 Class Sporozoa
770 Class Ciliata
771 Subclass Protociliata
772 Subclass Euciliata
790 Subclass Suctoria
799 [Zooplankton]
1000 [Plankton]

PLANT KINGDOM

1050 Subkingdom Thallophyta
1011 [Division Phycophyta] [Algae] [Phytoplankton]
1012 Phylum Cyanophyta

1013 Phylum Chlorophyta
1014 Phylum Phaeophyta
1015 Phylum Rhodophyta
1016 Phylum Chrysophyta
1017 Phylum Euglenophyta
1018 Phylum Pyrrophyta
1019 Phylum Charophyta
1020 [Division Mycophyta] [Fungi]
1021 Phylum Schizomycophyta
1022 Phylum Myxomycophyta
1023 Phylum Eumycophyta [Molds]
1024 Class Phycomycetes
1025 Class Ascomycetes
1026 Class Basidiomycetes
1027 [Mushrooms]
1028 [Lichens]
1037 Subkingdom Embryophyta
1038 [Bryophyta]
Phylum Cryophyta
1040 Class Musci
1041 Class Hepaticae
1042 Class Anthocerotae
1043 [Pteridophyta]
1044 Phylum Tracheophyta
1045 Class Psilophytineae
1046 Class Lycopodineae
1047 Class Equisetineae
1048 Class Filicineae
1070 [Spermatophyta]
1071 Class Gymnospermae
1072 [Trees]
1073 Class Angiospermae
1074 [Wild Flowers]
1075 [Cacti]
1077 [Shrubs]
1078 [Cultivated Plants]
1079 [Grasses]
1080 [Aquatic Plants]

## SUBJECT CLASSIFICATION

(Direct Categories)

1. Anatomy, Histology
2. Embryology, Metamorphosis, Development
3. Physiology, Reproduction
4. Behavior, Psychology
5. Intraspecific relations, Sociology

6. Interspecific relations, Symbiosis, Parasitism
7. Ecology, Bionomics
8. Geographic distribution, Natural regions
9. Introductions, Invasions, Migration
10. Taxonomy, Nomenclature, Systematics, Common names
11. Evolution, Phylogeny, Fossils, Genetics
12. Toxicity, Medicine, Venoms
13. Soil, Agronomy, Geology
14. Meteorology, Temperature relations
15. Freshwater biology, Water, Water relations
16. Marine biology
17. Limnology
18. Special regions, Deserts, Caves, Tropic, Arctic, Antarctic
19. Forestry, Dendrology, Siviculture, Forests
20. Economic, Agriculture, Control (Chem., Biol.)
21. Conservation, Conservation education
22. Recreation, Natural History, Hobbies, Travel
23. Methodology, Collecting, Rearing, Mounting, Photography
24. Special Books, Pictorial, Children's, References, Paper backs

SUMMARY

A system for coding General Biological references on marginal punched cards has been designed to fit an inexpensive card. This system utilizes a standard alphabetical subdivision for author and publisher of separate publications. Codes are presented for Geographic Distribution and Taxonomic Categories. Twenty-four direct categories are given for subject matter, categories suitable for classifying general publications. The adaptability of the system to a more specialized field is discussed.

BIBLIOGRAPHY

Anon. 1949. Webster's geographical dictionary. C. & C. Merriam Co., Springfield, Mass., xxxi + 1293 pp. + 24 pls.

Anon. 1950. Library of Congress processing Department, Subject Cataloging Division, Classification, Class Q, Science (5th ed.). U. S. Government Printing Office, Washington, vi + 215 + 21 pp.

Anon. [n.d.] Keysort for the bibliographer. Royal McBee Corp., Port Chester, N. Y., Form S-422, RI, 4 pp.

Anon. [n.d.] Keysort punching and sorting manual. Royal McBee Corp., Port Chester, N. Y., Form S-600 R-56, 28 pp.

Biological Council. 1954. A list of abbreviations of the titles of Biological journals (2nd ed.) (Selected from World list of scientific periodicals). H. K. Lewis & Co., London, iv + 31 pp.

Byer, M. D., J. E. Cantlon and C. M. Wetmore. 1959. A punch card technique for studying species and species-environment associations. Ecology **40**(2): 323-324.

Casey, R. S., *et al.* (eds.) 1958. Punched cards: their application to science and industry (2nd ed.). Reinhold Publ. Corp., N. Y., 697 pp.

Cox, G. J., C. F. Bailey and R. S. Casey. [n.d.] Punch cards for a chemical bibliography.

Reprinted from Chem. & Eng. News. The McBee Co., Port Chester, N. Y., Form S-422, 4 pp.

DENMARK, H. A., H. V. WEEMS, JR. AND CARLIS TAYLOR. 1958. Taxonomic codification of biological entities. Science, **128:** 990–992.

DEWEY, MELVIL. 1958. Dewey Decimal classification and relative index (16th ed.) Forest Press, Inc., Lake Placid Club, N. Y., 2 vol., viii + 2439 pp.

FRIEDMAN, B. D. 1955. Punched card primer. Pub. Admin. Serv., Chicago, Ill., 77 pp.

HARTKEMEIER, H. P. 1952. Punch-card methods. W. C. Brown, Dubuque, Iowa. 360 pp.

LEVINE, N. D. 1955. A punched card system for filing parasitological bibliography cards. Jour. Parasit., **41**(4): 343–352.

MCGAW, H. F. 1952. Marginal punched cards in college and research libraries. Scarecrow Press, Washington. 218 pp.

SCHWABE, C. W. AND L. R. DAVIS. 1954. Marginal punched cards in veterinary research. Amer. Jour. Vet. Res., **15**(57): 634–637.

# ABSTRACTS OF HONORS PAPERS

Presented by Members of the Graduating Class of 1959
Denison University

At Denison University an honors project may be undertaken by a senior student who makes application and who has fulfilled certain scholastic requirements. When recommended by his academic Adviser and approved by the Curriculum Committee of the Faculty, the student investigates a selected topic in his field of concentration, and finally submits a thesis which summarizes his findings. If this is approved, by his adviser and an appointed committee of readers, as of high quality, and if he then passes his comprehensive examinations with high ratings, he thereby earns the right to graduate "with Honors".

Following are the names of students of the Class of 1959 who fulfilled these requirements, their advisers and the department in which their work was carried out, the title and an abstract of each thesis submitted. These are presented in alphabetical order.

## THE RELATIONSHIPS OF CONGRESS WITH THE FEDERAL COMMUNICATIONS COMMISSION

SUZANNE JO DOUGLAS

Adviser: Frederick M. Wirt
Department of Government

This study—the relationships of Congress with the Federal Communications Commission—is an examination of the ways in which Congress may exercise influence and control, through direct or subtle measures, over the FCC.

The FCC is one of six major independent regulatory commissions (IRC). The six agencies are organized on a similar basis; each is a multiheaded board which controls a large segment of the economy through the exercise of legislative, executive and judicial functions. The FCC controls communications by radio, television, telephone and telegraph. Thus, as an independent regulatory commission, it stands in a unique position with regard to the tripartite American government. As an IRC it is intended to be independent of executive and judicial control. It is created to be independent of legislative control, also, except that it is created by Congress.

This study examined three areas (appropriations, personnel and policy) in which Congress may possibly exercise control, in an attempt to determine if the FCC *is* free from congressional control or if it is hampered by Congress in carrying out its functions. Study of government documents, as well as personal in-

terviews with commissioners and congressional staffs, led to the following conclusions.

Congress exercises a small degree of control through the appropriations process. In order to carry out a program an agency must have money. Congress, therefore, through supplying money may control what an agency may or may not do. Only once in the past fifteen years has Congress appropriated as much as the FCC requested. Some of these cuts were economy cuts, not unusual; but others were designed to prevent certain programs from being put into operation. On the whole, though, Congress has not used this process to its fullest extent.

The second major way in which Congress may control the FCC is through confirmation of nominations to the agency. The President nominates and the Senate confirms appointments to an IRC. The Senate nearly always confirms the appointments; but in doing so the Senators use the hearing stand as a place from which to "grind axes", to inquire concerning the policy of a nominee, and to seek to hold him to his statement or to impress on him policy convictions of their own. Statements by commissioners and congressmen show that nominees *do* listen to what congressmen say at this time. Thus, here is a significant and effective control.

The third, and most effective, control is that of dictating procedures and policy. Statutory policy statements such as the Administrative Procedure Act and the amendments to the Communications Act have actually hampered FCC procedure. Investigations have had their effect through censure of FCC actions by Congress and its committees, as well as through public opinion. Finally, subtle pressures have had a good deal of effect. A letter or phone call from a congressman may determine the action of the FCC in a particular case.

These are the three major techniques for congressional oversight. One further condition is necessary: the controls must be effective. In the case of the FCC the oversight *is* effective. Its effectiveness lies in the fact that although the FCC is supposedly independent, when Congress says, "Follow this certain policy", the FCC will, in most cases, follow.

## A RHETORICAL ANALYSIS OF FIVE PASSAGES IN THE BOOK OF ST. MATTHEW

KATHLEEN ALTER ELDER

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Department of Speech

The specific purpose of this project was to investigate selected passages from the Gospel of St. Matthew in an attempt to determine what rhetorical processes were at work in making these passages effective as speeches.

This project indicates that the rhetorical strength of the passages analyzed rests in the appeal of "pathos" which, in turn, is based on the powerful ethical appeal of the man, Christ. The chief logical appeal of the speeches was found in the form of the enthymeme; and the major instrument through which the emotional appeal was made was the vivid illustration.

## AN EXPLORATION OF *THE SOUND AND THE FURY* THROUGH THE IDIOT BENJY

ROBERTA ANNE HANKAMER

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This honors project is an attempt to clarify certain events in William Faulkner's novel, *The Sound and the Fury*, by a close study of significant details and their relationships. Most of these occur in the section devoted to the idiot Benjy, where to the casual reader the prose is often merely boring and to others an insolvable puzzle. The book is like a huge cryptogram which when solved says a great deal about human nature, and even more about the novelist's technique in portraying human nature.

Each of the four sections of the book is written in the light of the personality of its teller. In Benjy's section this presents a problem for the reader since Benjy is an idiot, incapable of speech, without speech pattern of any sort, unable to do more than moan or cry to express his feelings verbally.

One example of the mode of presentation of character is Benjy's great awareness of the accepted way of doing things. This is best demonstrated in the episode at the statue on Jefferson's Square:

> I could hear Queenie's feet, and the bright shapes went smooth and steady on both sides, the shadows of them flowing across Queenie's back. They went on like the bright tops of wheels. Then those on one side stopped at the tall white post where the soldier was. But on the other side they went on smooth and steady, but a little slower. (p.31)
>
> "Hum up, Queenie", T. P. said. The shapes flowed on. The ones on the other side began again, bright and fast and smooth, like when Caddy says we are going to sleep. (p.32)

This is the order, the way things were to be done. Benjy was accustomed to the fact that when he was in the carriage and drove around the square the shadows on one side stopped, while others went more slowly at the moment. He did not know why, but it was customary and therefore good.

Contrasted with this is the episode near the end of the novel:

> They approached the square, where the Confederate soldier gazed with empty eyes beneath his marble hand into wind and weather . . . Ben sat, holding the flower in his fist, his gaze empty and untroubled. Luster hit Queenie again and swung her to the left at the monument.
>
> For an instant Ben sat in utter hiatus. Then he bellowed. Bellow on bellow, his voice mounted, with scarce interval for breath . . . .
>
> With a backhand blow (Jason) hurled Luster aside and caught the reins and sawed Queenie about . . . and swung her to the right side of the monument . . .
>
> Ben's voice roared and roared. Queenie moved again, her feet began to clop-clop steadily again, and at once Ben hushed. Luster looked quickly back over his shoulder, then he drove on. The broken flower drooped over Ben's fist and his eyes were empty and blue and serene again as cornice

and facade flowed smoothly once more from left to right, post and tree, window and doorway and signboard, each in its ordered place. (pp.335–336)

Thus the world is ordered for Benjy, despite his lack of intelligence. Habit is the strongest form of order, and Ben realizes the proper position through constant repetition of the sameness. A wrong-way turn by Luster to show off in front of a group of his friends is a break in the habit which Ben knows. This is bad, to him, and therefore he bellows in rage. When it is corrected and the shadows again move in their normal and ordered pattern he is happy, and his noise subsides. The 'ordered place' is of great importance to Benjy. If the order breaks, the main tie which connects him to the world he sees is broken, for he knows things only through order and association.

The above illustration is cited as an example of the technique used throughout the paper to meaningfully explicate and logically reconstruct Faulkner's novel.

## SHAFTESBURY, KANT AND SCHILLER: A PROGRESSION IN THE IDEAL OF HUMAN FREEDOM

BARBARA HAUPT

Adviser: Guy Stern
Department of Modern Languages

This essay represents a search for currents of thought converging in a great thinker and poet and for his utilization of these ideas in his works. It tries to show how the philosophies of the Third Earl of Shaftesbury and of Immanuel Kant converge in Friedrich Schiller's metaphysics, ethics and aesthetics. More tentatively, it suggests Schiller's application of his aesthetic theory in his own drama.

Schiller became engrossed in the Shaftesbury tradition of philosophy during his years at the Karlsschule, and his first essays express a concern much like Shaftesbury's: a humanistic interest in the sources of human behavior and character, a humanistic quest for the most favorable operation of these forces to educate internally harmonious "free" men, and a conviction that art should help to serve this end. This remained an absorbing interest all through Schiller's life. The young Schiller also shared with Shaftesbury a conviction of "natural harmony" which had three-fold implications: 1) a belief in a creative hand at work throughout nature, 2) an ethical monism, an assurance that moral goodness was "natural", and 3) a conviction that a man whose life exhibited this innate rightness was truly free. Like Shaftesbury the young Schiller held that artistic creation took part in this cosmogony of natural harmony, that art was the product of a creative genius like that which formed the harmonious Whole that was nature, and in "living" miniature art reflected the Truth of the Whole.

Although these concerns that he shared with Shaftesbury reached deeply into Schiller's theory, his thought took a new direction beginning in 1790. His vocabulary changed startlingly, mirroring basic changes in his thought. Schiller was intensely absorbed in the philosophy of Immanuel Kant. He had read the *Critique of Aesthetic Judgment* first and then went on to study the *Critique of Pure Reason* and the *Critique of Practical Reason.* Thought clashed against

thought, as Schiller contended with an intellect as penetrating as his own. He had anticipated many of Kant's ideas, partly because they were in the intellectual air of the time, partly because his own mind worked in ways similar to Kant's. Like Kant, he was seeking intensely for a basic understanding of the human situation, the operations of the mind, the moral greatness or the moral bankruptcy of the soul. He asserted a sharp dualism in metaphysics, ethics, and aesthetics, opposing form to matter, reason to sense, subject to object. Schiller emerged from his intellectual struggle with Kant metaphysically deeper and more somber; he held to an uneasy dualism in all areas of thought and to a critically sharpened "subjective" aesthetics. But he did not relinquish his desire for spiritual harmony and an "objective" aesthetics.

In his Late Classical writings Schiller achieved a synthesis of his early theory and his Early Classical theory, which inclined heavily toward Kant. Philosophically refined by Kant, Schiller found an equilibrium between the Shaftesburyan ideal of harmony and Kant's goal of spiritual, "rational" freedom. Using Kant's critical tools to analyze the human situation—from "savagery" to the intellectual "barbarism" of the times—Schiller concluded that human beings could become really free only by first becoming "harmonious" persons. And art had a special mission to make them so. In his theory of "the aesthetic education of man" Schiller employed art for an educative, ultimately moral, purpose. In his theories of "beauty" and "sublimity" he drew on man's moral dimensions for an explanation of art's most profound effects. The progression of Schiller's dramas reflects to a considerable extent the progression of his thought. His ideal of freedom and his theories of art are finely and consciously woven into the fabric of his drama. Theory and works mutually illuminate one another.

## THE HYDROLYTIC STABILITY OF SODIUM AND POTASSIUM BOROHYDRIDE

MARY LUCILE HERING

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Department of Chemistry

Rate studies were conducted on the hydrolysis of sodium borohydride, $NaBH_4$, and potassium borohydride, $KBH_4$, in alkaline buffered solutions. Three principal conclusions can be drawn from this study.

The rates of hydrolysis of sodium and potassium borohydride were determined by placing a weighed sample of the commercial crystalline borohydride in an alkaline buffered solution of known pH. At time intervals, aliquots of this sample were analyzed by allowing the borohydride to react with a known excess of $KIO_3$ and then determining the amount of $KIO_3$ remaining, by titration with $Na_2S_2O_3$. Rate studies were conducted in several different buffers from pH 12.93 to 10.4 in a constant temperature bath at 25.0 $\pm$ 0.1°C. Without exception, the hydrolyses were first order with respect to borohydride concentration.

Secondly, the relationship of the hydrolysis to hydronium ion concentration was studied by plotting values determined for log k′, the first-order rate constant, against pH. This plot showed that the hydrolysis is first order with respect

to hydronium ion concentration when the pH is less than 12.45 and is 0.44 order when the pH is greater than 12.45. The change in order is possibly due to a change from an acid-catalyzed mechanism to a base-catalyzed mechanism.

The last phase studied was a comparison of $NaBH_4$ and $KBH_4$ under the same laboratory conditions. The results of this study, together with other available data, show that the two behave identically throughout the entire alkaline pH range.

Thus it has been established that the hydrolysis is first order with respect to borohydride ion concentration throughout the alkaline pH range; that the hydrolysis is first order with respect to hydronium ion concentration when the pH is less than 12.45 and is 0.44 order when the pH is greater than 12.45; and that, under the same laboratory conditions, sodium borohydride and potassium borohydride behave identically with respect to hydrolytic stability.

## EXTINCTION OF THE ABORIGINE: THE BIOLOGICAL IMPLICATIONS IN THE DISAPPEARANCE OF UNIQUE CULTURES

MARY DAISY JUDITH KERSTING

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Department of Biology

Life is a dynamic process of selection and reselection to changing external and internal environmental conditions. The survival of man is dependent upon the ability of his adaptive mechanisms to function in correlation to the environments from which he is never separated. Therefore the study of the primary hypothesis on which this research has been grounded, that the extinction of aboriginal cultures can be directly correlated with biological implications, necessitates a study of the physical, biotic, and internal environments of man.

Man has been singularly successful in utilizing the skills peculiar to his species to meet the challenges of his physical environment. This unique ability to control and modify the environment, accompanying a wide reaction range to environmental factors, has been determinant in the survival of aboriginal groups. Consequently, human extinction is not correlatable with physical environmental factors alone.

The interspecific and intraspecific environments of man are in a state of perpetual variation. There exists a direct or indirect relationship between all living organisms of the biotic environment. Any cataclysmic changes within one intraspecific environment will cause disruption in areas of the total environment, a disturbance in the food chain being an example of this phenomenon. The decreasing aboriginal populations of Australia were influenced indirectly by a change in dietary conditions. However, the effects of an altered environment were more significant in North America. The decimated populations of specific Indian tribes in the northern Great Plains region were both directly and indirectly a resultant of the destruction of the primary food source, the bison.

The internal environment is of prime importance in the extinction of the aborigine. Lack of previous exposure to certain disease microorganisms precluded the

aborigine from inheriting a natural resistance or from possessing the biological mechanisms necessary for rapidly acquiring immunity. Research has shown that small-pox was the most important biological contributory factor in the extinction of the aborigine. Populations in the South Pacific area, Central America, and North America were greatly decimated, and many completely wiped out, as a result of this ravaging disease. Tuberculosis, venereal diseases, measles and other contagious diseases were influencing factors in the declining populations of the South American regions. Measles was the whole cause of the extinction of the Ona Indians of South America and of the near-extinction of the Yamana Indians of the same country.

Statistics indicate that complete extinction did not always occur as a result of the factors discussed. However, the devastating effects on the populations are significant as they reveal that the possibility of extinction prevails until a new level of adaptation is reached and maintained. The introduction of curative medicines and vaccines, education of native populations on the modes of sanitation and disease prevention, gradual development of natural immunity, and the adaptation of new ways of life, all prevented further decimation from occurring.

In summary, the results of the research presented here show:

1) The physical environment is not significant in the extinction of the aborigine; 2) the biotic environment is an indirect causal factor; 3) the internal environment and the inability to adapt immediately to new influences are directly correlatable to extinction; and 4) biological causes are of major significance in the extinction and population-decimation of contemporary aboriginal man.

## THE DESIGN AND THE DIRECTION OF *THE GLASS MENAGERIE*

MARY SUSAN LEECH

Adviser: Edward A. Wright
Department of Theatre Arts

This project discusses the background of Tennessee Williams and his play, "The Glass Menagerie." A director's plot of the action is outlined. Original set, lighting, and costume designs, as well as complete working drawings of the construction of the set, are included.

A final summation is made concerning the director's solution of the problems in directing the play and presenting it for four public performances in the Denison University Theatre.

## FRENCH SOCIETY IN THE NINETEENTH CENTURY SEEN THROUGH A SELECTED GROUP OF NOVELS

SARAH STARR POWELL

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Department of Modern Languages

This paper (written in French) is a study of the daily life of 19th century France as reflected by the following novels.

*Le Rouge et le Noir* (1830) by Henry Beyle
*Eugénie Grandet* (1833) By Honoré de Balzac
*Cousine Bette* (1845) by Honoré de Balzac
*Madame Bovary* (1857) by Gustave Flaubert
*L'Education sentimentale* (1869) by Gustave Flaubert
*L'Assommoir* (1877) by Emile Zola
*Le Ventre de Paris* (1889) by Emile Zola

By choosing novels by these four authors an attempt was made to cover as much of the century as possible and to include a variety of social classes and ways of life. *Le Rouge et le Noir* is a chronicle of French life in 1829 under the Restoration. The society which Beyle (Stendhal) describes is that of the *haute bourgeoisie*, and the struggle of the lower classes, represented by Julien Sorel, to obtain liberty and equality for themselves.

Balzac intended to give an enormous fresco of French society, for the Revolution of 1789 to that of 1848. *Eugénie Grandet* and *Cousine Bette* are two novels included under the general title of *La Comédie humaine*. Unlike Stendhal, Balzac uses people from all classes, but mostly the *bourgeoisie*. He attempts to show the evil consequences of the Revolution of 1789 and especially the exaggerated importance which money had acquired.

In *Madame Bovary* Flaubert shows the dangers to which extreme romanticism can lead. The principal theme is the romantic desire for happiness which the ordinary world cannot satisfy. Flaubert, in *l'Education sentimentale*, describes Paris of the last years of the reign of Louis-Philippe and of the Revolution of 1848. Like Balzac, Flaubert shows the downfall of the old wealthy classes.

Zola himself admits his desire to be the Balzac of his age, the Second Empire. In his novels, grouped under the general title of *les Rougon-Macquart*, Zola portrays the life of the workers and peasants. In *l'Assommoir* Zola shows the downfall of a poor working family in the suburbs of Paris. We witness the tragic ruin of the worker, who is replaced by machines, and the bad influence of alcohol, the workers' only compensation in life. *Le Ventre de Paris* describes the life of the vast *Halles* of Paris, and the work and passions which go into providing food for all of Paris.

These selected novels thus serve to illustrate that—the main aspects of nineteenth century France are those of a country in a state of change. It is a period of struggle for "liberté, égalité, and fraternité". The greatest changes appear in the social classes, with the downfall of the old aristocracy and the rise first of the bourgeoisie and later of a completely new class, the workers. We witness the terrible conditions of the workers, brought about by the Industrial Revolution. France of the nineteenth century was in a period of transition—from the France of kings, of inequality, of splendor, and of luxury, to the France of today, a democratic country with equality and rights for all. Life at the end of the century still had not all of the conveniences which are enjoyed today; but enormous progress had been made.

## RELATIONSHIPS BETWEEN ANOMIE AND OTHER MEASURES OF ADJUSTMENT IN THE DENISON STUDENT BODY

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This study is concerned with the concept anomie, a term developed by Durkheim, meaning a state of goallessness or normlessness in a society. The term has since been expanded to mean the state of anxiety in an individual in which he is unable to identify himself with existing norms and goals, and feels isolated from others. The purpose of this study is to test the hypothesis that there is a relationship between anomie and the degree of social adjustment, emotional adjustment, and academic adjustment among Denison students.

These terms are used in the following sense. Social adjustment: the student makes friends easily, is liked and accepted by others, and participates in a number and variety of activities.

Emotional adjustment: the student makes best use of time and abilities, has insight into himself and recognizes his own deficiencies, makes decisions and sticks to them, and has some direction in life.

Academic adjustment: the student does his work on time, attends classes regularly, seeks more than grades from class activity, and is able to achieve his potential.

Material was procured through the following methods:

1) A questionnaire composed of four scales—the Srole anomie scale and three original scales testing for social, emotional, and academic adjustment;

2) The number of activities and leadership positions of each individual (activities taken as the principal criterion for social adjustment);

3) The A/P index, found by dividing the student's potential (as measured by ACE or SAT test scores, obtained before the student's first semester in college) by his cumulative point hour ratio, to give the degree of academic achievement at Denison (used as the principal criterion for academic adjustment);

4) A rating of each student's social, emotional, and academic adjustment by the same four persons, chosen because of their knowledge of the students and of student adjustment problems.

The questionnaire was administered to, and information obtained on, 256 students (32 men and 32 women from each class), who were chosen by disproportional stratified sampling on a selected interval basis.

Two types of results were obtained—one using comparison of total scores by the Chi-square technique, and one comparing the 40 individuals with high anomie scores (denoting a high degree of normlessness) with the individuals with low (0) anomie scores. The results were similar. They showed a negative correlation between anomie and social adjustment, the anomic individuals likely to be as well adjusted socially as the other students. There was also a negative correlation between anomie and academic adjustment, the anomic individuals

having as good an academic adjustment (able to achieve their potential) as the others in the sample. A positive correlation was found between anomie and emotional adjustment, there being poorer emotional adjustment in the anomic individuals.

Emotional adjustment proved to be the only factor in this study indicative of anomie or associated with it. Social and academic adjustment do not seem to be affected by a high degree of anomie, possibly implying that compensation for anomie may occur in these areas. Anomie was found to be more prevalent in men than in women, decreasing in men with advance in class rank, and increasing in women.

## A NEW CONCEPT OF THE DRAMA: BRECHT'S THEORY OF THE "EPIC THEATER" AS SEEN IN HIS FIRST DRAMAS

GORDON SHUTES FERGUSON

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Department of Modern Languages

The subtitle of a recent book describes Brecht's concept of the theater as "non-aristotelian"; and many present day students of the theater have argued that Brecht's is indeed the first new theater theory since Aristotle. In this prevailing atmosphere of extravagant praise and occasional violent disavowal an attempt is made to examine Brecht's concept and its applicability to his early (most programatic) plays.

Presented first is a distillation of Brecht's basic assumptions and aims, culled from his theoretical works. Then these assumptions are analyzed as to what effect they have on his creative works. The final step is a summation coupled with some comments on Brecht's technique of metamorphosing old style plays into epic theater.

Thus Brecht's works are to be considered as proving grounds for his theory. Needless to say this is not equivalent to a value judgment of Brecht's plays. The success or failure of his theory within his plays is something distinct from their ultimate effect and viability. The final word on his controversial plays will still be long in coming; future critics may do worse than to take Brecht's own standard for theater, a standard based on whether or not pleasure is afforded to the audience: "Vergnügung ist die nobelste funktion, die wir für 'Theater' gefunden haben".[1]

It may be argued that Brecht sets up specific formulas and then does not adhere to them himself. But whenever he abandons his theories for traditional, Aristotelian, theater he does so only because he feels that this technique in a few cases leads to a better communication of his message to his audience. More often, however, Brecht's theater is consistent with his theories. And these

[1] Bertolt Brecht, *Versuche* (Berlin, 1951), XII, 111. "Entertainment is the noblest function which we have found for theater."

theories represent a significant revolution in the theater, a revolution that will affect the stage for years to come.

## TWO METHODS OF STUDYING THE KINETICS OF SIMPLE BINARY GLASSES

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Part I. *A Method of Studying the Kinetics of the Devitrification of Simple Binary Glasses*

A brief review of the mechanism of crystal formation in simple glasses and a discussion of the instrumentation of the 90 degree diffractometer is presented.

A method of measuring the total crystallinity of a glass sample was developed. This method was based on the work of Klug and Alexander and consisted of the establishment of a calibration curve for a given sample of glass. This curve represented a relationship between the percentage crystallinity in a sample of glass and the peak intensities of the crystalline material present in the glass. These intensities were measured by the X-ray diffractometer. This method is known as the "internal standard" method.

It was concluded, also, that the application of the "lever rule" to data collected on the maximum crystallinities of glasses of constant composition formed under varied melting conditions would yield an extremely accurate determination of the phase diagram for the system under consideration.

Part II. *A Method of Studying the Kinetics of Assimilation of Pure Silica into Simple Silicate Melts*

In the concept of glass formation postulated by McKinnis and Sutton the formation-rate of simple soda-silica glasses is considered to be a function of the dissolution of silica in the silicate melt. This silica is present to a finite extent in low temperature melts.

An attempt was made to measure the dissolution rate of silica. This was based upon the predicted insolubility of silica in phosphoric acid at 300 degrees Centigrade. At this temperature it was assumed that treatment of a glass sample with concentrated phosphoric acid would dissolve away the silicate melt, leaving a residual deposit of silica.

It was determined, however, that this method was inapplicable in this particular study, since silica was found to be soluble in phosphoric acid to the extent of 7 % to 11 % at 250 degrees Centigrade and above.

## THE DEPENDENCE OF THE VISCOSITY OF SIMPLE GLASSES ON MELTING HISTORY

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For a silicate glass melted at temperatures not far above its liquidus temperature, two viscosity curves are obtained: one for increasing temperatures and the other for decreasing temperatures. The two curves can be explained satisfactorily on the basis of the degradation-reorganization process postulated by McKinnis and Sutton. A transition point occurs at approximately 100–250 degrees C above the liquidus temperature involving a structural rearrangement between the low temperature structure consisting of large, relatively immobile silicate ions and the smaller, more mobile anionic units characteristic of the high temperature melt with the corresponding distribution of the bridging oxygen function. The two viscosity curves converge in the low temperature region indicating that the structure stable at high temperatures reverts to that stable at low temperatures, a fact not previously observed by other investigators.

For a glass melted at temperatures high above its liquidus, only one viscosity curve was obtained, indicative of the existence of only one system of structural units at all temperatures for this particular melting history. Activation energies for viscous flow have been calculated as a function of temperature for a glass melted under these conditions. This is the first time this has been done.

It is concluded from the experimental results obtained in this investigation that the melting history of a glass exerts considerable influence on the structure of the glass in the liquid phase as interpreted from viscosity studies, and also that additional experimental verification has been obtained for the theory of the nature of silicate melts proposed by McKinnis and Sutton.

## THE BOER WAR AND THE BRITISH POLITICAL SCENE

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Department of History

The struggle of Boer and Britain in South Africa was a tragedy with results that affect Commonwealth relations to this day. To assess guilt or levy blame is not the purpose of this study.

This paper is an attempt to show the influence of the Boer War on the British political parties. To accomplish this aim an attempt is made to explain the problems in South Africa in the later years of the nineteenth century and to

show how they involved Great Britain in a war. There is also a summary of the main happenings in British politics from 1886 to 1895.

Rather than to give a day-by-day account of the war and its influences on British politics, the plan is to select several of the most controversial episodes and issues and to examine them in detail. It is assumed that these representative selections serve adequately to show the outstanding effects of the war on the British political scene.

## THE SYNTHESIS AND REACTIVITY WITH SODIUM IODIDE OF DIETHYL CHLOROMETHYLPHOSPHONATE AND DIETHYL BETA-CHLOROETHYLPHOSPHONATE

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Diethyl chloromethylphosphonate (I) and diethyl beta-chloroethylphosphonate (II) were synthesized and their rates of reactivity with sodium iodide (dissolved in acetone) were studied, in order to get some idea of the electronic and steric effects that might be operative in these compounds.

Compound (I) was synthesized in about 41 % yield by the Yakabovich method, that is by reacting chloromethylphosphonic dichloride with sodium ethoxide. Compound (II) was synthesized by an Arbuzov-Michaelis type of reaction (a method not previously used to prepare this compound) in which 1-chloro-2-bromoethane was reacted with triethyl phosphite. Yields in this reaction were about 37 %. Both (I) and (II) were carefully purified by vacuum fractional distillation, and certain physical properties were measured before using these compounds in the rate studies with sodium iodide.

The reaction of NaI with halogen compounds is usually one of simple substitution and occurs in the following manner.

$$Na^+I^- + Cl{-}(CH_2)_x{-}P(O)(OC_2H_5)_2 \xrightarrow{\text{(acetone)}} I{-}(CH_2)_x{-}P(O)\cdot(OC_2H_5)_x + \underline{Na^+Cl^-}$$

By measuring the consumption of sodium iodide at fixed time intervals reaction rates for compounds (I) and (II) were obtained and rate constants were calculated, assuming second order kinetics.

(I) was found to be relatively unreactive with NaI in acetone, having an average k value of 0.022 liters moles$^{-1}$hours$^{-1}$. This lack of reactivity was attributed mainly to steric hindrance by the $-P(O)(OC_2H_5)_2$ grouping, since earlier workers in other studies had found that this diethylphosphonate group had a strong tendency to be electron-withdrawing, which (in the absence of steric factors) should tend to increase the reactivity of halogen attached to a methyl group such as is found in (I).

(II) was found to be somewhat more reactive with NaI in acetone, but the rate "constant" steadily decreased with time. (This reaction did not fit the pattern for 1st order kinetics either.) Initially the rate of reaction

k (after approx. 6 hours) = 0.129 liters moles$^{-1}$hours$^{-1}$ was comparable to that of its carbon analog, ethyl 3-chloropropanoate.

It is suggested that the decrease in the reactivity of (II) with time may be due to a secondary (consecutive) reaction occurring with the first reaction product, diethyl iodoethylphosphonate. This compound could undergo a beta-type elimination (a reaction not uncommon for this type of compound) to form hydrogen iodide, HI, according to the following equation.

$$I—CH_2—CH_2—P(O)(OC_2H_5)_2 \rightarrow CH_2{=}CH—P(O)(OC_2H_5)_2 + HI$$

The HI produced in such a reaction would not be distinguishable (in the analysis used) from the unreacted sodium iodide. Thus there would be less "apparent" consumption of iodide ions than actually did occur in the initial reaction between sodium iodide and (II).

## THE EFFECT OF REINFORCEMENT SCHEDULE AND AWARENESS ON VERBAL CONDITIONING

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Department of Psychology

The present study was an investigation into reinforcement schedule effects and awareness effects on verbal conditioning. A total of 67 *Ss* was used, 60 of whom were obtained from introductory psychology classes and seven from an introductory biology class, at Denison University. The 60 psychology students were divided 15 each into Fixed Ratio, Fixed Interval, Continuous, and Control groups. The seven biology students were run on the FR schedule.

Cards bearing a verb and the six personal pronouns—"I", "We", "You", "He", "She", and "They"—were presented individually to the *Ss*. They were instructed to construct a simple sentence, beginning it with one of the pronouns and using the verb in the sentence. *Ss* were reinforced with 'Good' for their "I" and "We" responses. For the first 120 trials the Continuous Group was reinforced for every critical response, the FR Group for every other critical response, and the FI Group for the first critical response following a 15 second interval after the last reinforced response. The last 160 trials were presented without any reinforcement.

By the statistics used it was found that the FI and Continuous Groups conditioned, but the FR Group did not. An analysis of variance and an analysis of covariance both failed to show any difference among the groups during extinction.

In an attempt to investigate awareness as a possible variable causing failure to get conditioning in the FR Group, seven *Ss* from a biology class were run on the FR schedule. An analysis of variance on these *Ss*' acquisition responses, and acquisition responses given by non-aware *Ss* from the original FI and Continuous Groups, gave an $F$ value less than one.

The analysis of variance on extinction responses of these groups approached significance. The analysis of covariance was significant almost to the .01 level.

Thus with non-aware *Ss* a reinforcement schedule did seem to influence extinction responses.

*T*-tests, run between aware and non-aware *Ss* on the same reinforcement schedule, showed the following results.

(a) New FR and original non-aware FR *Ss* significant beyond the .01 level.

(b) New FR and original aware FR *Ss* significant beyond the .05 level.

(c) Original aware FR *Ss* and original non-aware FR *Ss* were not significant.

(d) Original aware Continuous *Ss* and original non-aware Continuous *Ss* were not significant.

In discussion it was brought out that reinforcement schedules seemed to influence extinction responses of non-aware *Ss*, but did not seem to influence extinction responses of aware *Ss*. Because of this difference and the conflicting results involving the possible awareness and selection variables, shown by the *t*-tests above, further research into awareness influences and influences from the *Ss*' past experiences in verbal conditioning situations is suggested.

## FROM EMPIRE TO COMMONWEALTH, 1917–1931. A STUDY OF THE INTERACTION OF DOMINION NATIONALISM AND BRITISH IMPERIALISM

DAVID WILLIAM SAVAGE

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In 1917 Lloyd George summoned an Imperial War Cabinet to London, thus creating a new precedent in inter-imperial relations. The Prime Ministers of the British Dominions of Canada, Newfoundland, Australia, New Zealand and South Africa, and a Maharajah representing India met with the Cabinet of the British Government to facilitate the conduct of the First World War. This was the first meeting of the heads of the Dominion governments during a war fought in every corner of the British Empire.

A spirit of national independence had developed in those parts of the British Empire already enjoying self-government in internal affairs. This spirit, heightened by the First World War, was the driving force in the evolutionary development of The British Commonwealth of Nations. Dominion nationalism steered the course of Imperial England from a policy of paternal domination to one of sympathetic tolerance. By showing a willingness to hearken to the pleas for independence, British statesmen prevented the complete separation of the Dominions from the mother country.

If Dominion nationalism was the active force in the evolutionary process, then the counter-balance was the British desire to retain the glory that had been the Empire. Without this element in British thought, the Little Englanders would have had their war, and Dominion nationalism would have found expression in complete separation. A sense of Empire, shared by British subjects in the Dominions, counter-balanced the desire for national independence and kept the Empire from disintegrating into unrelated national units.

Exceptions, of course, prove the rule. The cases of India, Burma, and Ireland do not neatly fit the pattern established by Canada, Australia, New Zealand

and South Africa. These latter nations followed an uncharted course in order to arrive at a constitutional relationship of equal status, "united by a common allegiance to the Crown, and freely associated as members of the British Commonwealth of Nations". The unwritten constitution of the Commonwealth evolved, as have other British institutions, as specific problems were answered with specific solutions, thus creating new precedent upon which future action is based.

The Imperial War Cabinet of 1917 was the first of the post-war series of events characterized by a desire to affirm Dominion nationalism and at the same time preserve and strengthen the bonds of imperial union. The most responsible Dominion statesmen rarely expressed a desire to withdraw from the Commonwealth, but rather demanded complete national autonomy within the imperial structure. More complete autonomy in international affairs was achieved when the Dominions were accorded representation at the Versailles Peace Conference and the resulting League of Nations. During the 1920's the Dominions established their independence in matters of foreign policy but remained dependent upon the British fleet and foreign service. During this period the economic bonds of empire were strengthened. By 1932 Great Britain had adopted a protective tariff and could offer preferential rates to goods of Dominion origin. Finally, in 1931, the last vestiges of an old colonial subordination were removed from the Dominions with the enactment of the Statute of Westminster. This document recognized the complete autonomy of the British Dominions, leaving only the Crown and a tradition of cooperation to bind together the British Commonwealth of Nations.

## STIMULUS GENERALIZATION IN SUBLIMINAL PERCEPTION

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Subjects (*Ss*) were presented with stimuli from four lists of five five-letter words each: 1) the "original" word list; 2) the "synonym" word list—words similar in meaning to the original words; 3) the "physical" word list—words physically similar to the original words; and 4) the "associative" word list—words often associated with the original words, though opposite in meaning.

These stimuli were projected during two experimental sessions at low intensities onto a field of light. One hundred trials were presented in each session. The stimuli used in the first session consisted of the "original" words for all *Ss*. *S* was instructed to give on each trial the following indicators of perception: a) a semantic indicator of awareness, where *S* reported what he could see of the projected word, and b) an accuracy indicator, where *S* guessed the word that was being projected from among those in the list, whether he could "see" anything or not. The experimenter adjusted the intensity of the projected word to such a level that *S* could give a semantic report on about 30% of the trials. The occurrence of a significant number of false-negative responses (where *S* could give no semantic report but still identified the word correctly by guessing) above a chance level defined subliminal perception.

For the second session, *S*s were randomly divided into four groups, and each group was presented the words from one of the four lists. Except for those presented with the "associative" list, all *S*s were instructed that words other than those from the first session would be presented part of the time. *S* was still to indicate what he could see (semantic indicator) and guess at the correct word from the "original" word list (accuracy indicator). Subliminal perception was again determined on the basis of a significant number of false-negative responses.

Since the "associative" words were considered as responses frequently given to the "original" words when they are used as stimuli, the "original" words were presented to the "associative" group, and *S* was instructed to give responses from the "associative" list rather than from the "original" list.

False-negative responses in the first session were significantly above a chance level. In the second session, they occurred significantly often only in the control group (which received the "original" words a second time). True-positive responses (where *S* was able to discriminate correctly at least a part of the word, and also made a correct "guess") were understandably significantly above chance for the groups in which false-negative responses were above chance. In the "physical" word group, only the true-positive responses were above chance in the second session. In the groups using "synonyms" and "associative" words, all types of responses, including the true positive, were at a chance level, indicating that the presentation of these stimuli in no way aided *S* in guessing the "original" words.

The following conclusions were drawn: Subliminal perception was established when the "original" words were presented and *S* had to guess from among them. No evidence for any stimulus generalization to related words was obtained. However, the presentation of stimuli physically similar to the correct words aided *S*'s guessing only if he could also report the discrimination of some part of the stimulus. Stimulus generalization in subliminal perception, if it occurs at all, is restricted to dimensions of physical similarity, and does not occur along dimensions of meaning.

## CAMUS ET L'EXISTENCE

ANDRE EMILE WINANDY

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Department of Modern Languages

Une étude sur le problème de l'existence, tel qu'il se révèle dans l'oeuvre d'Albert Camus: de "L'Envers et l'endroit" à "la Peste".

## THE STYLE AND INTERPRETATION OF THE KEYBOARD WORKS OF JOHANN SEBASTIAN BACH

PHILIP EMERSON WYSE

Adviser: Robert M. Miller
Conservatory of Music

The present revival of interest in the music of Bach has engendered a violent controversy between the purists who seek an academic style of performance and the romantics who proclaim the universal excellence of modern principles

of style. The controversy has absorbed much of the potentially constructive energy of the two factions, leaving few guides for an intelligent understanding of Bach's style.

This project is in part an investigation of documentary materials about Bach's life and documents by Bach, and in part the practical application in a public piano recital of the principles of musical style expressed in these documents. Particular attention was given to ornaments as an organic part of the music as well as expressive devices. Problems of tempo, dynamics, rhythm, and phrasing are discussed in the project and instruments of the Baroque and modern periods are compared briefly.

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